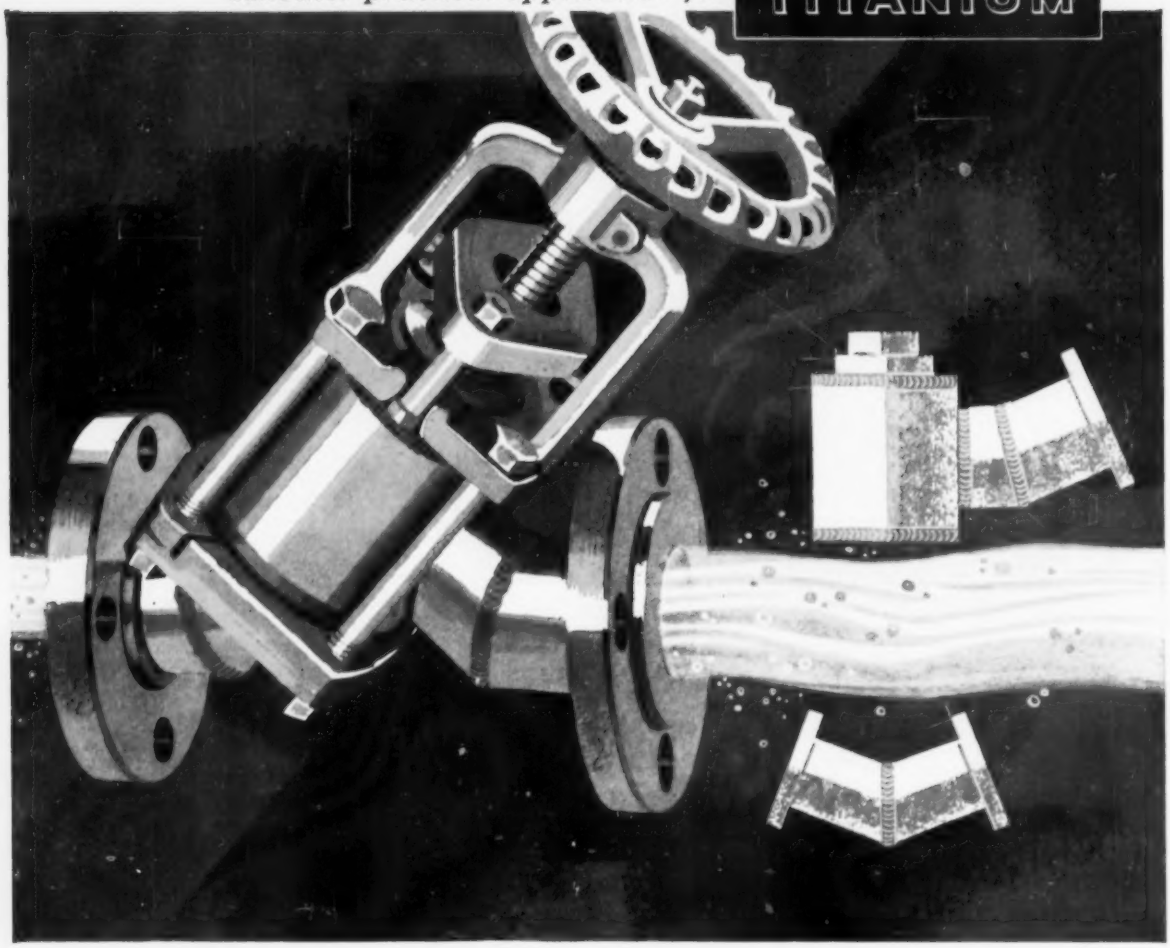
Metal Progress • MAY 1959

Another practical application for **TITANIUM**



"CORROSION SPECIALISTS" TURN TO TITANIUM

...for working parts of new DURCO® valves

The Duriron Company, Inc., manufacturer of "Durco" valves and pumps, specializes in design and manufacture of equipment for corrosive service. Now they're among the first to turn to titanium . . . producing, to order, fabricated valves used in highly corrosive applications. These valves are specially designed for handling hot nitric acid, hot chlorides, organic acids, mixed acids, etc.

In the Durco Type K "Y" valve, shown above, *all metal parts in contact with corrosive solutions are Mallory-Sharon titanium.* Mallory-Sharon engineers worked closely with Duriron designers on welding and forming techniques for the new valves. Mallory-Sharon titanium mill products are also being used in a Durco plug valve and a new line of corrosion resistant "Durcopumps".

For help in applying titanium's unusual corrosion resistant properties to *your* processing equipment, write for Technical Data Sheet on *Titanium Valves for Chemical Service.* Please address: Commercial Market Development, Department B, Mallory-Sharon Metals Corporation, Niles, Ohio.

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1959 DESIGN ENGINEERING SHOW
PHILADELPHIA · MAY 25-28

Metal Progress

May 1959 . . . Volume 75, No. 5

Cover shows coils of cold rolled strip steel moving on conveyer at Youngstown Plant of new Stainless and Strip Div. of Jones & Laughlin Steel Corp.

Engineering Articles

Stress-Relieving Titanium Alloy Weldments, by Robert P. Brody and Alfred A. Taylor 67

Compressor cases made of 5% Al, 2.5% Sn titanium alloy cracked on stress-relieving. The problem was solved by altering the heating cycle. Previously heated in 200° F. increments, the case is now placed in a cold furnace and heated directly to 1150° F. (J1a; Ti-b, 7-51)*

Rating Heat Transfer Surfaces for Corrosion, by N. D. Groves and C. M. Eisenbrown 78

A new test can accurately determine weight loss of a metal immersed in a corrosive solution. Specimen and corrodent can be maintained at different temperatures simulating heat transfer conditions. A typical problem in heat exchanger design is solved with curves developed from this test. (R11a, R6g; SS)

A Metallograph for the Mill, by G. H. Boss 81

A portable metallograph, complete with polishing and etching equipment, has been devised for shop use. Designed for examining heavy machine components on the spot, optical examination at 900 × is possible, and good photomicrographs at 250 × have been obtained. (X4a, X4e)

Flow Coat Finishing Today, by E. A. Zahn 84

It's time to take another look at flow coat finishing, especially if you investigated it in the past and turned it down. Refinements enable the process to handle many finishing operations more efficiently. (L26n)

Flow Coating Nike Missile Parts, by D. A. Harrington and E. A. LeGare 87

A system for automatic processing and flow coating is suitable for finishing large missile fins, yet is flexible enough for numerous small parts. Paint utilization is over 95% and quality of coating is good. This application suggests advantages of the flow coat method for finishing in other industries. (L26n)

Removing Sulphur and Silicon From Hot Metal, Staff Report 91

A "rotary reactor" is expected to supplement or replace some of today's steelmaking processes. Hot metal, arriving from a blast furnace, is poured into a rapidly rotating drum, and spreads over the inside wall in a thin layer. Strong alkalis, iron ore and oxygen are added to reduce sulphur and silicon to low values. (D8n; ST, S, Si)

Welding Electrode With Built-In Kinks, by Thomas W. Shearer 95

This corrugated electrode compensates for wide trim tolerances by depositing an extra wide weld bead that straddles the seam. (W29h; 4-61)

Etching Reagents for Dislocations in Metal Crystals, by L. C. Lovell, F. L. Vogel and J. H. Wernick 96

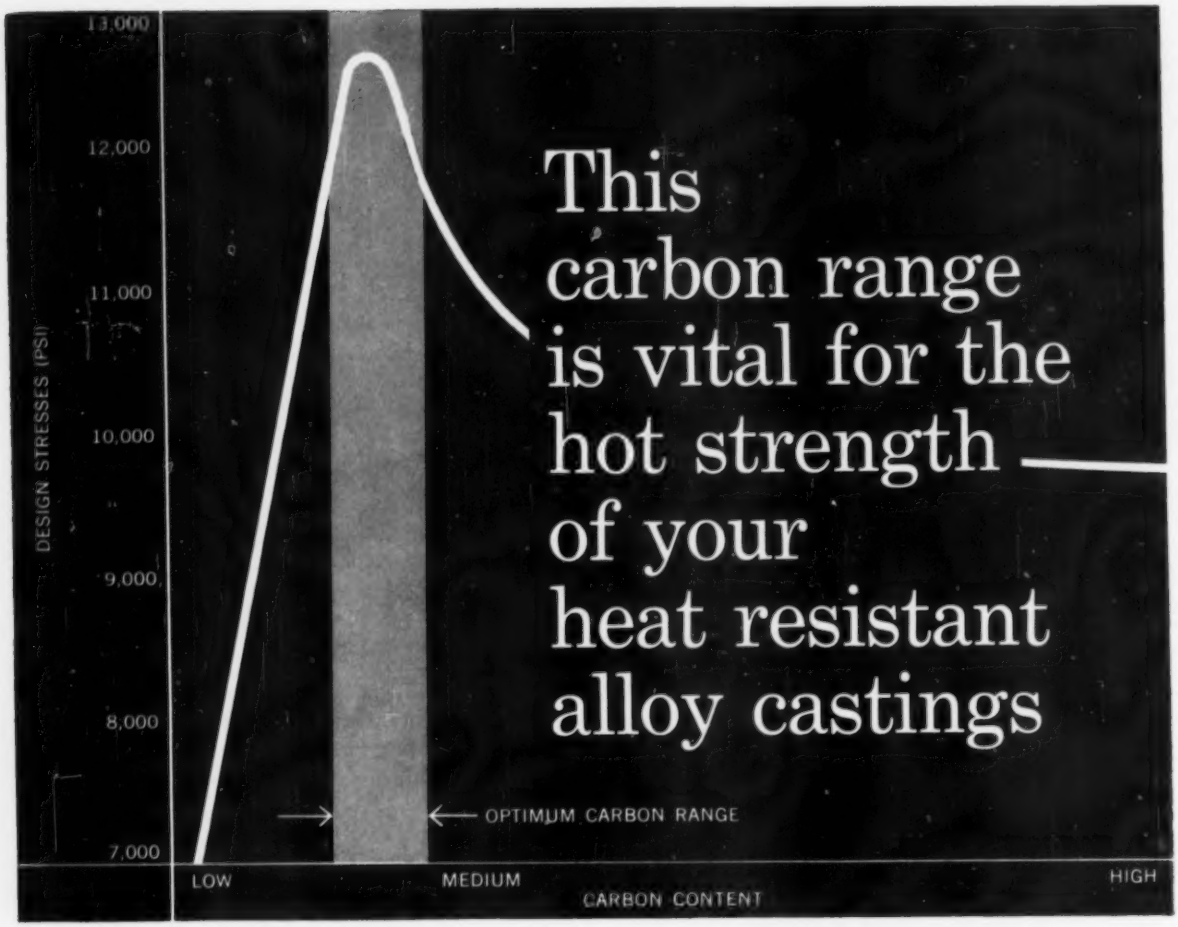
General methods and precautions. Data sheet on p. 96-B lists recommended etching solutions and times for various metals, and shows some typical results. (M20q, M26b)

Metals for the Atomic Boiler, by B. Lustman 97

Water at 530° F. and 200 psi. is highly corrosive, even when alkalinized and carrying hydrogen in solution. The Shippingport reactor vessel is lined with Type 304 stainless steel, and all piping and heat exchanger tubing are made of the same alloy. (T11, 17-57; SS, Zr-b)

Table of Contents Continued on Page 3

**The coding symbols refer to the ASM-SLA Metallurgical Literature Classification, International (Second) Edition, 1958*



Every foundry heat is analyzed to insure specified alloy composition

This graph illustrates the effect of carbon content on the hot strength of a heat resistant alloy. It outlines an optimum carbon range. The graph shows how a carbon content outside the optimum range would seriously lower the hot strength decreasing the service life of the casting. The optimum carbon range is 0.10 percent.

Controlling carbon content to within one-tenth of one percent is difficult, but Electro-Alloys does it. Compositional control of castings at Electro-Alloys is exact and painstaking. Without this care you cannot expect maximum efficiency and long service life.

We have compiled an imposing file of data on the effects of carbon in alloy composition, and we can relate that data to your needs. To stop rising replacement and maintenance costs, check with us on carbon content while equipment is in the design stage. Contact Electro-Alloys Division, 1015 Taylor Street, Elyria, Ohio, and we will take all steps to insure the optimum composition for your casting.

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Metal Progress

Contents Continued

Continuous Furnace Improves Annealing, by A. G. Sturrock 103
Cycle annealing in a continuous furnace insures uniform structures in bars and throughout different lots of steel. Loads are carried through automatically after proper times and temperatures are selected. There are also provisions for protective atmosphere and carbon restoration. (J23, W27g, 1-61; ST)

Metal Processing in Russia, by Arthur B. Tesmen 106
Continuous casting of steel, ultrasonic treatment of freezing metal, and vacuum rolling are all receiving attention from Russian metallurgists. The first is on its way to success; the others are in the laboratory stage. (D9q, D9k, F23, 1-73; ST)

Brazing Under an Electric Blanket, by Donald E. Wernz and Mel Schwartz 109
This new brazing technique appears as a substitute for furnace brazing in a number of applications. It is said to be cheap and efficient; equipment is compact. The method shortens production cycles considerably. (K8, 7-59)

New Techniques for Testing

Analyzing Segregates by Spectrograph, by J. K. Hurwitz 72
A motor-driven specimen stage and photographic plate enable continuous analyses to be made across segregated zones in polished samples. Banded structures, welds and nonmetallic inclusions can be readily analyzed by this method. (S11k, 9-69)

Impact Test for Evaluating Toolsteels, by Gary Steven 76
A shallow (½-in. radius) notch in the standard Charpy impact specimen is suitable for rating toughness of hardened toolsteels. Several different grades are compared, along with the effects of various heat treatments on a single grade (M-2). (Q6r; TS)

Critical Points

Peaceful Satellites 65

Data Sheet

Etching Reagents for Dislocations in Metal Crystals, by L. C. Lovell, F. L. Vogel and J. H. Wernick 96-B

Book Review

A Useful Appraisal of Radiation Effects on Materials, Reviewed by Joseph M. Beeston 120
J. J. Harwood, H. H. Hausner, J. G. Morse and W. G. Rauch, editors of "The Effects of Radiation on Materials" are also the organizers of the conference which resulted in these papers presented at Johns Hopkins University in March 1957.

Digests of the Month

Vacuum Melting Stainless Steels and Superalloys 138
Both induction and consumable-arc methods are detailed and compared in this paper presented at the Western Metal Congress in March of this year.

Investment Castings 144
Seven papers presented at a meeting of the Investment Casting Institute last June give an exhaustive coverage of this important process.

Short Runs

Rating Oil Stains on Cold Rolled Aluminum, by L. B. Sargent 113
Welded Aluminum Mine Cars, by J. R. Flynn 114
Graphitized Textiles Have Many Uses 115
Push Buttons Operate New Die Shear 116
Beryllium Is Now Being Forged 117
Titanium + Palladium = Better Corrosion Resistance 117

Metals Engineering Digest

Ultrasonic Inspection of Aluminum 154
Cracking Due to Stresses in Gray Iron Castings 158
Effect of Surface Finish on Fatigue 172
Acid Resisting Property of Steels 174
Solar Furnace in Nonferrous Research 180
Austenite Transformation Behavior 188

Correspondence

Aluminum Powder Parts at High Temperature, by R. J. Towner 122
Quality Control in Specialty Steel Production, by J. S. Pendleton, Jr. and H. O. Beaver, Jr. 122
Metallurgical Dragon, by C. A. Moe 122
Oxy-Acetylene Flame, by Harold Lurie 124
Barnyard Pals, by June Chung 124
Compacts of High Green Strength, by C. F. Tisinai 126

Departments

Press Breaks 5
Application and Equipment New Products 23
New Literature 37D
Personals 128
Advertiser's Index 218

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These incomparable annealing results prove

LEE WILSON'S OPENED COIL METHOD BEST!

Those familiar with annealing will recognize the chart below as an outstanding example of controlled uniformity in annealing.

This large 13-ton coil was subjected to 90 tests after it had been annealed in just 7¼ hours. From inside to outside Rockwell variance was held to an amazingly low three points.

This is not the exception, but rather the rule when steel is annealed by the new Opened Coil method developed and perfected by Lee Wilson engineers. Two pilot plants—one for tinplate and one for carbon steels—are now under construction—will soon be placed in operation in two of America's leading steel plants.

TABLE 1

SUMMARY PHYSICAL TESTS, METALLURGICAL TEST

SIZE: .0359" x 42¼" x 76½"

PART: EXTERIOR DOOR PANEL

Weight 26,900 — Al-Killed Steel

		Outside as Annealed					Center		Inside as Annealed				
		1	2	3	4	5	6	7	8	9	10	Average	Range
ROCKWELL HARDNESS	E_1	43	44	43	44	44	43	43	43	44	44	43.5	43/44
	C	44	42	42	43	44	43	43	44	44	43	43.2	42/44
	E_2	43	42	44	44	44	42	42	44	45	44	43.4	42/45
OLSEN DUCTILITY	E_1	415	415	420	420	420	420	420	415	415	415	417.5	415/420
	C	410	415	415	425	420	420	415	420	415	415	417.0	410/425
	E_2	410	415	420	425	415	415	415	415	415	420	416.5	410/425
MICRO GRAIN SIZE	E_1	6	6/7	6/7	6/7	7	7	7/8	7/8	7	7/8	.....	.....
	C	6/7	6/7	6/7	6/7	7/8	7/8	7/8	7/8	7/8	7/8	.....	.....
	E_2	6/7	6/7	6	6/7	7/8	7/8	7	7	7	7		

		L	T	L	T	L	T
TENSILE RESULTS	Yld. Str. (psi)	27,540	27,780	26,460	27,010	26,750	27,780
	Tens. Str. (psi)	44,910	45,290	45,760	45,210	46,680	47,050
	% Elong. (2")	40.0	39.0	40.0	38.0	39.0	39.0

Opened coil being rewound into a tight coil after annealing by Lee Wilson's patented coil handling system.

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ORIGINATORS AND LEADING PRODUCERS OF OPENED COIL AND SINGLE STACK FURNACES

Press Breaks...

ENROUTE FROM CLEVELAND to the Western Metal Exposition and Congress in Los Angeles in mid-March, the editor-in-chief stopped off at Santa Fe and went up to Los Alamos to iron out some remaining problems on our forthcoming book on plutonium. It will be the proceedings of four sessions held by the A.S.M. under sponsorship of the U. S. Atomic Energy Commission at the last World Metallurgical Congress. Arthur Coffinberry, who leads the work on plutonium at Los Alamos, organized this notable international meeting and final editorial touches to the record are being given by Bill Miner, past-chairman of Los Alamos Chapter ⛑.

While there he read of a heavy snow fall over the Great Lakes region and was moved to wire Marjorie Hyslop, managing editor, back in Cleveland: "Temperature 65, elevation 7000, sunshine 100%, ceiling infinite, visibility 75 miles". These are just some of the things that endear the Rocky Mountains to its inhabitants.

Los Alamos is on the edge of Frijoles Canon (Bandelier National Monument) with ancient cliff dwellings and remains of a 400-room pueblo which had been suddenly abandoned by the Indians seven centuries ago for no reason yet discovered by the archaeologists. However, the Pueblo Indians moved down into the river valleys and live much as they always have, these tribes being the only Indians in the United States which have survived, and have not been dispossessed and moved into reservations.

A fascinating method of dating these ruins was perfected by A. E. Douglas of the University of Arizona, wherein the relative widths of growth rings in the roof timbers are related to the amount of rainfall year by year. By matching tree to tree, the chronology back to A.D. 930 has been established in the pueblos of northern New Mexico, back to the time of Christ in Basket-Maker ruins in southwestern Colorado, and to 1300 B.C. in the sequoia region of California.

For such recent chronology the tree-ring method is more accurate than measuring the wood's radioactivity. The latter method depends upon the principle that radioactive ${}_6C^{14}$ is constantly being formed by cosmic ray bombardment of atmospheric nitrogen (${}_7N^{14}$). Radioactive carbon has a relatively short half-life – about 5500 years – and decays back to ordinary nitrogen, so air equilibrium is established such that plants which fix atmospheric CO_2 into cellulose and other hydrocarbons or charcoal made therefrom have radioactivity equal to 12.5 counts per min. per g. of carbon. When the plant stops growing, this activity starts to decline. The result is that wood from an Egyptian tomb believed to be about 4600 years old has 7 counts per min. (which checks the 5500-year half-life of ${}_6C^{14}$), and carbon in coal, petroleum and diamonds, hundreds of millions of years old, has no detectable radioactivity.

However, it is doubtless much more fun to count wood rings than Geigers.

⛑ ⛑ ⛑

Could it be, praise God, that there are so many neutrons and other elemental particles in the space overlying our atmosphere that an ICBM with an atomic warhead would be automatically exploded enroute to its target?

THE EDITORS

Why Leading Metal Engineers Select Ferrotherm for Atmosphere Heat Treating

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This case history, and many others, appear in Ferrotherm's now 4-page Newsletter. Send for your copy today.

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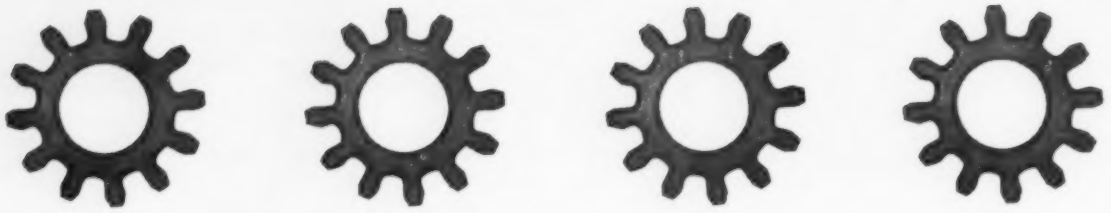

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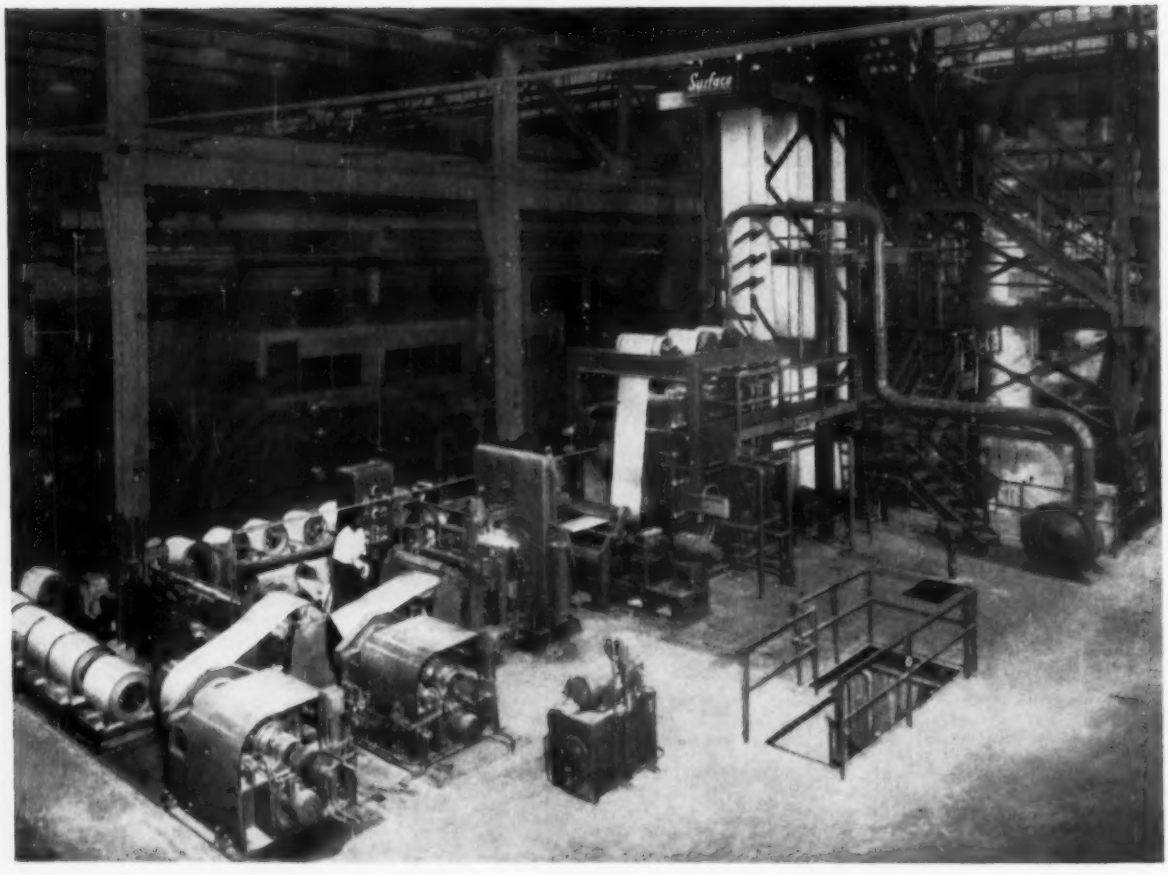
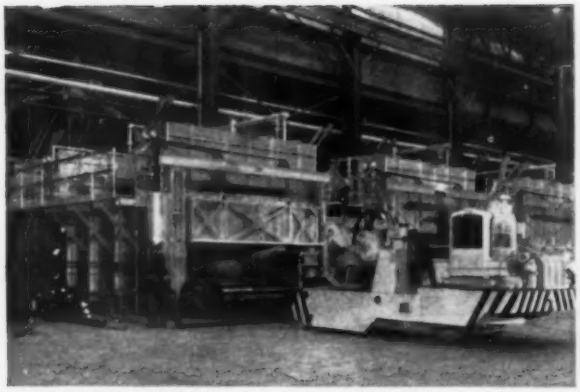
heat nonferrous metals faster...

Incredible speeds have been achieved in this new continuous brass strip heating installation by Surface.



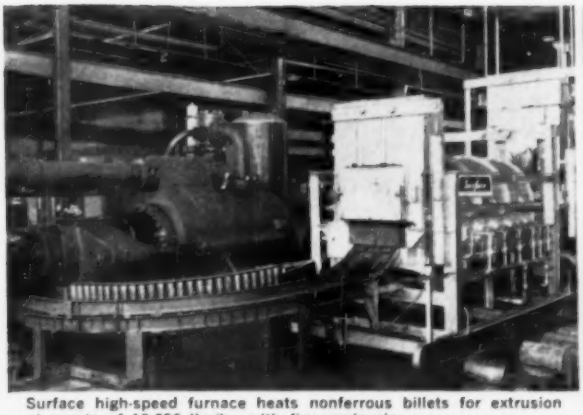


A big aluminum billet is removed from one of a battery of Surface furnaces which heat 7000 lbs/hr each for forging.

Thousands of 14S aluminum parts a day are solution heat treated and aged in this Surface continuous furnace line.

with new method by Surface

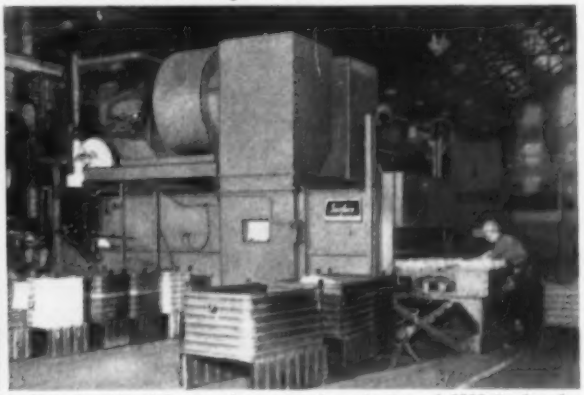
wherever heat is used in industry



Surface high-speed furnace heats nonferrous billets for extrusion at a rate of 19,250 lbs/hr, with fine grain size.

"Super convection" cuts the cycle time in this precision bell annealer. Direct-fired heating's in the base.

Specified grain size of 0.040 mm is held easily in this Surface continuous bright annealer for copper tubing.



This direct-fired furnace has a rated production of 2500 lbs/hr of aluminum blocked forgings.

ENGINEERING

IBM 704 COMPUTER permits General Electric engineers to analyze case stresses mathematically, correct design faults before fabrication begins. Computer is one example of advanced engineering capability which provides better case design, 230,000 psi strengths.

METALLURGY

G-E ARC-SPRAYED TUNGSTEN nozzle liners (melting point: 6170°F) are now being incorporated into lightweight, advanced nozzle designs. Early hot tests indicate that extremely high nozzle performance can be attained, a potential provided by G-E advanced metallurgy.

MANUFACTURING

INTEGRAL SKIRTS AND DOMES are roll-formed in General Electric solid propellant cases. Case halves are joined by a single girth weld as strong as the case itself. General Electric is applying more than six years of roll-forming experience to case manufacture.

ROCKET ENGINES

New solid propellant cases with . . .

230,000 psi YIELD STRENGTH

Solid propellant rocket motor cases with yield strengths in the range of 230,000 psi are now under development at General Electric in conjunction with the Thiokol Chemical Corporation. These full-size cases are among the strongest and most advanced in the U.S. missile industry. They will be used to contain and direct the powerful forces generated in the powerplants of highly advanced solid propellant missiles.

Now underway at General Electric are equally advanced developments relating to high temperature tungsten throat liners for lightweight nozzle applications. Liners such as these are now being incorporated into advanced nozzle designs being developed by Thiokol Chemical Corporation.

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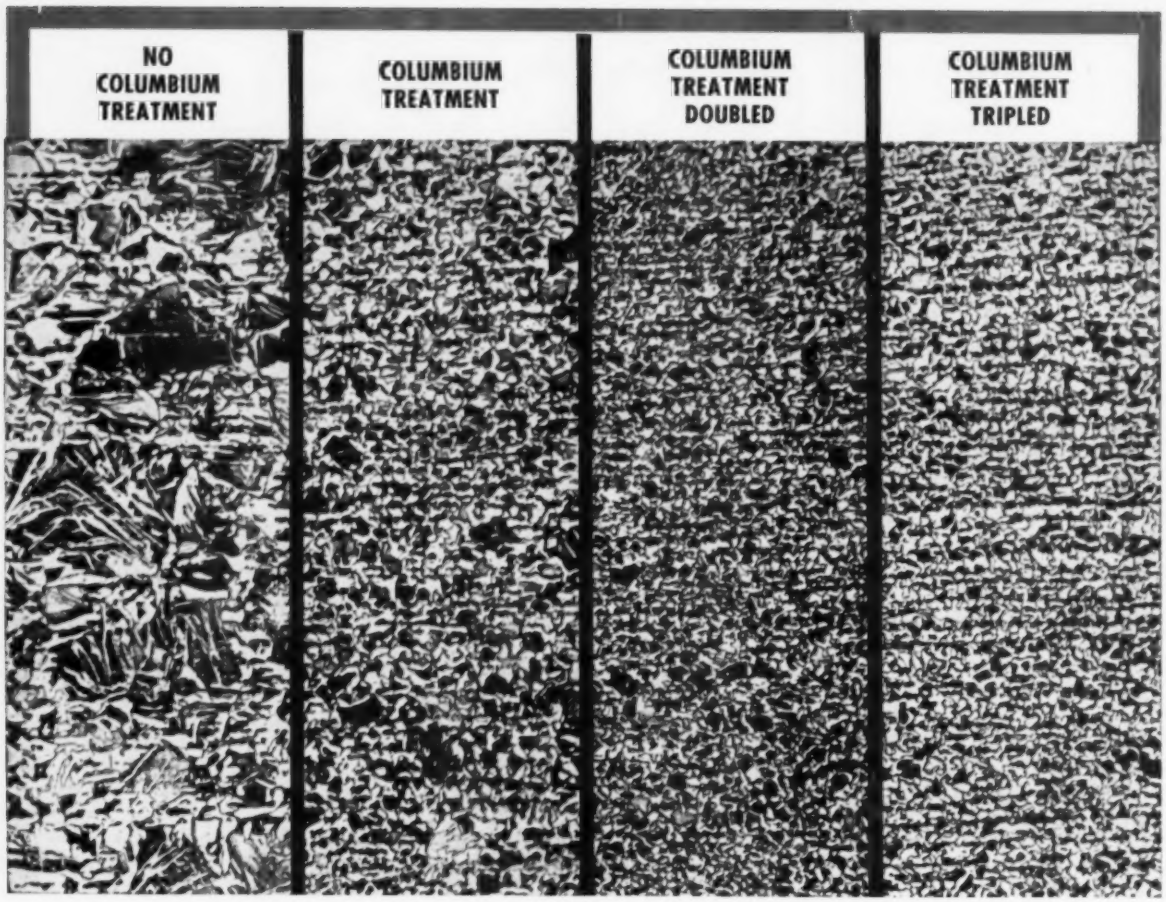

Composite of photomicrographs made from the same heat of mild carbon steel shows the effect of varying columbium treatments on the grain structure of the steel.

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For this personal service—or for literature on any of the heating operations shown on these pages—address Dept. 35, Selas Corporation of America, Dresher, Pa.

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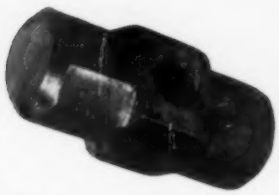
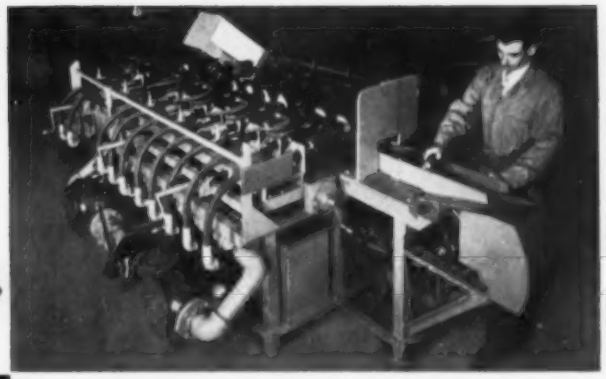
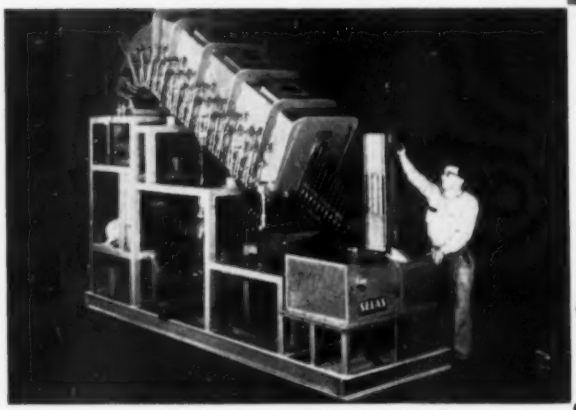
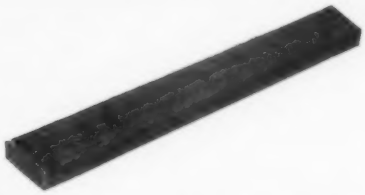


LOCALIZED HARDENING: Selas automatic machine heats, quenches and tempers both faces of sledge-hammer-heads in a continuous operation. Tempering, which previously required hours, is now performed in minutes. Machine handles wide variety of sizes, shapes and weights . . . production rate of a typical 8-lb head is 100 per hr. By integrating the heat-treating function with the preceding grinding step, there is no additional labor cost involved in the operation of the machine.







FORGING: This continuous Selas unit fits compactly into the production line to heat alloy steel bars for forging into C-shaped rail anchors. Production is synchronized with the forging bulldozer, at rates up to 620 bars per hr. Inventory of work-in-process is ½ to ¼ of previous equipment . . . 20% less floor space is occupied . . . 95% less scale is formed. Only two operators required for entire process—one to load heating machine, one to operate forge bulldozer. Precise heating assures consistently uniform grain structure and hardness, piece after piece.

HEAT TREATING: 400 motor rotors are heated per hr to 900°F in this automatically controlled machine for: (1) developing electrical and torque characteristics, (2) shrink-fitting on rotor shafts, (3) bluing the outer surface of the turned laminations. With steel and aluminum involved, close temperature control is achieved to avoid melting the aluminum. Machine occupies only 6 ft square floor space . . . replaces gas torch heating units requiring up to 10 times as much fuel, or low-temperature ovens requiring hours of heating time.

BRAZING: A Carboloy cutter is silver brazed to a stainless steel shredder ring used in garbage disposal units, with this compact Selas machine. Precise fixturing, localized high-speed heating and automatic unloading permits one operator to produce up to 200 pieces per hr . . . every piece to pass a 3000-lb load test. Completely shop-assembled at Selas, the package unit was installed in customer's plant, ready for production operations, within hours.

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Heat and Fluid Processing Engineers
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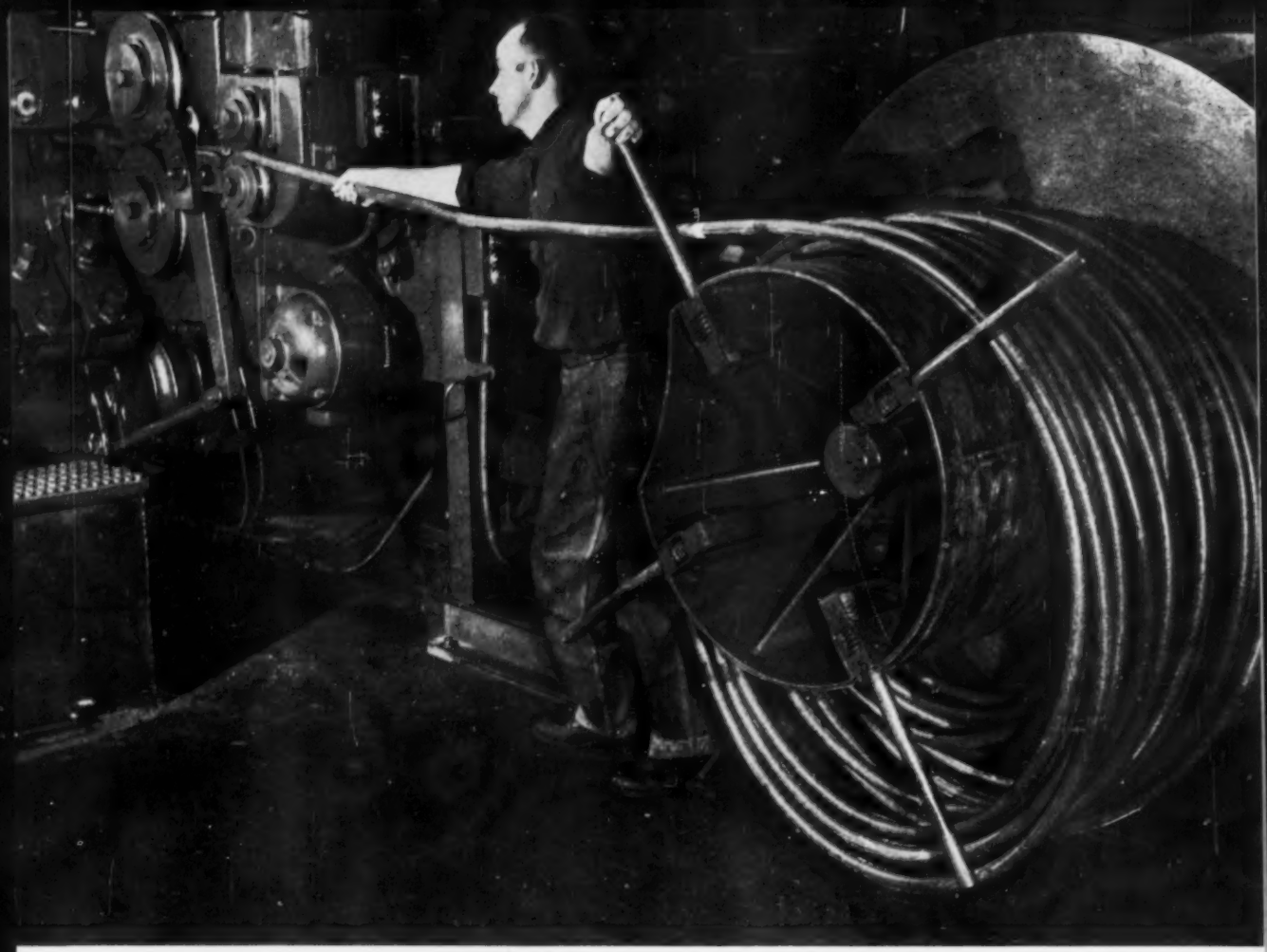


"New large coils of J&L hot rolled bars permit longer production runs"

. . . states industrial fastener manufacturer

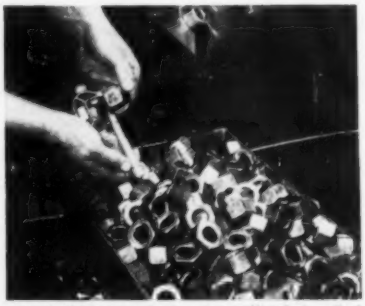
"Use of large coil weights in J&L hot rolled bars enables us to increase production through longer runs, reduced machine downtime," reports Mr. Robert McCombs, General Manager of Russell, Burdsall & Ward's Coraopolis, Pa., plant.

"We are able to cold form ¾" heavy hexagon nuts, 1¼" across the flats, from J&L's C-1110 scrapless nut quality bars, without surface cracks, at high speed. This is a severe test of hot rolled steel quality."

R. B. & W., one of the oldest and largest manufacturers of industrial fasteners, uses J&L steel in both low and medium carbon grades as well as the C-1110 steel.

Investigate J&L's superior quality hot rolled bars for your toughest cold forming applications. Bars are now available in coil weights up to 1300 pounds.

Call in a J&L steel specialist for recommendations on how to improve physical characteristics of your end products and to increase your production rate. Write Jones & Laughlin Steel Corporation, 3 Gateway Center, Pittsburgh 30, Pennsylvania.



J&L C-1110 scrapless nut quality hot rolled bars, 1½" diameter, are used in producing these R. B. & W. nuts, 1¼" across the flats, with ¾" tapped diameter.

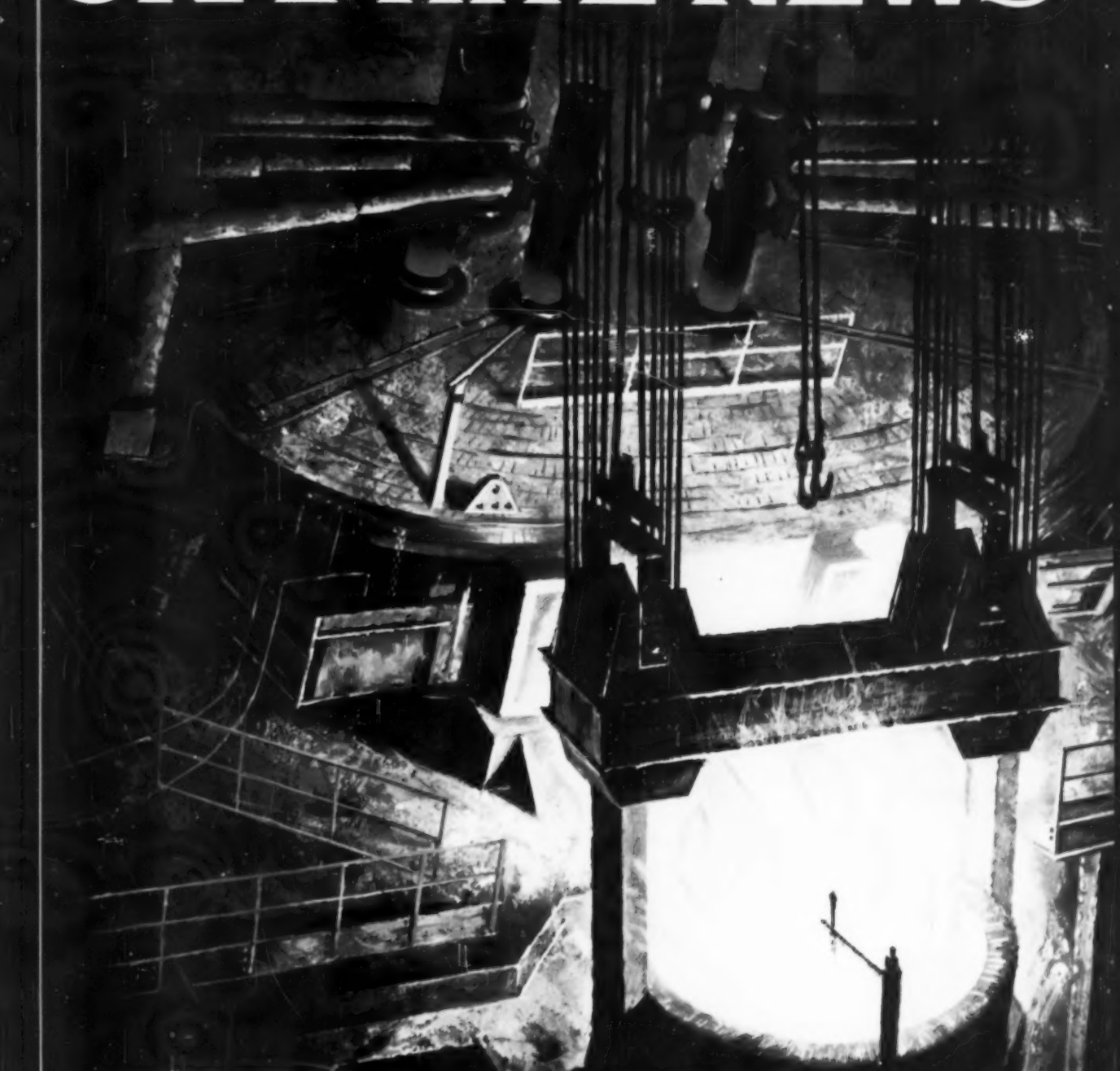
Jones & Laughlin Steel Corporation

PITTSBURGH, PENNSYLVANIA

Vol. 6 No. 1
MAY 1959

NATIONAL CARBON COMPANY'S

CARBON AND GRAPHITE NEWS



SIX-ELECTRODE ARC MELTING FURNACES

By Samuel Arnold 3rd
Consulting Engineer

SIX-ELECTRODE ARC MELTING FURNACES

By Samuel Arnold 3rd
Consulting Engineer

Samuel Arnold 3rd graduated from Pennsylvania State University in 1913 with a B.S. Degree. In 1918, he received an E.E. Degree from the same University. From 1916 to the present, he has been primarily concerned with the development, sale and use of Heroult electric arc furnaces. In 1927, he developed the use of multiple voltages as applied to arc furnaces. In 1928, he was responsible for the design of the first successful six-electrode steel melting furnace. Since 1925, Mr. Arnold has been Consulting Engineer for American Bridge Division of United States Steel Corporation.

INTRODUCTION

To keep pace with the demand for electric furnace steel, electric furnaces have continued to increase in size and use of power. In 1906, the first heat of electric furnace steel was made in the United States. The furnace used for this heat was built in France by Dr. Heroult and consisted of a rectangular shell with two electrodes for single phase operation. Shortly thereafter three phase power was utilized and the logical design was a cylindrical shell. These early furnace designs had a relatively shallow bath and were equipped with transformers of low capacity.

During the years that have followed, the development of arc furnaces has primarily consisted in increasing the shell diameters and height to give deeper hearth capacity as well as greater volume. At the same time, considerably increased transformer capacities have been furnished, together with controls of greater sensitivity. At present, the largest three-electrode cylindrical furnace has a shell diameter of 24′-6″, and power loads slightly in excess of 35000 KVA have been used. The 24′-6″ furnace has made heats greater than 200 tons, but perhaps the best

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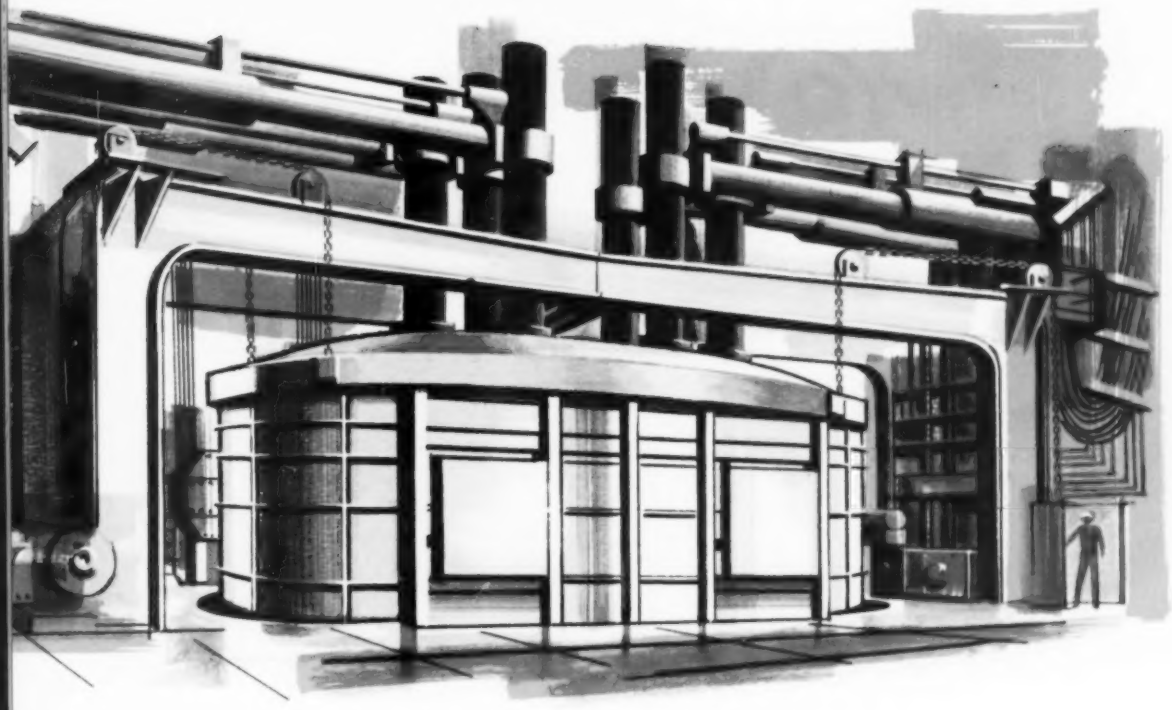
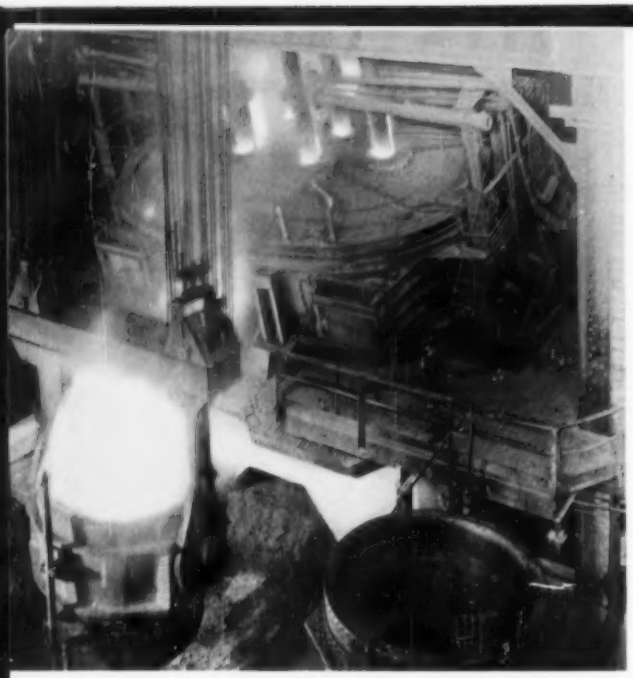


operating capacity is approximately 180 tons. Without question, larger furnaces can and will be built in the future, and it is important to consider the most effective design.

For many years, the primary function of arc furnaces has been the melting and refining of special high grade carbon and alloy steels. However, in the last fifteen years, the use of arc furnaces has been extended to the manufacture of ordinary carbon steels, and in that field they are competing favorably with open-hearths. The reason that arc furnaces can compete so favorably has been primarily due to the wide use of the removable roof for quick charging, and the use of larger transformers and better regulation. Since the Second World War, light scrap has been used in arc furnaces almost exclusively, and as the use of this light scrap gives greater area to absorb radiant energy, higher power, when properly applied, can speed the melt.

In the melting down process, high power applied to modern three-electrode furnaces is now used only until a bath has been partially formed. As a result, the use of high power is limited as to time, and, therefore, full use of the transformer cannot be obtained. This in turn decreases the load factor and increases the time to melt and production cost. How then can we obtain a better utilization of the power available in these proposed larger furnaces?

With three electrodes, there are three concentrated areas for the release of energy, and as long as the scrap area is maintained, this high energy can be absorbed. However, once the bath has been formed, superheating can occur in the energy liberating areas. This increases the energy radiated to the refractories. Unless the power load is diminished to correspond to the rate of heat absorption in the charge, refractory deterioration rapidly occurs. The logical answer to this problem as larger furnaces are built, is to provide more energy releasing areas for the same amount of power used, thus taking advantage of power availability to provide an efficient quick melt with a minimum of refractory deterioration. A multiple electrode furnace is, therefore, to be considered.



BIRTH OF SIX-ELECTRODE FURNACE

Thirty-one years ago the writer, riding by train from Pittsburgh to Canton, made a sketch of a six-electrode elliptical furnace and submitted the idea to the engineers of the Timken Roller Bearing Company. This preliminary design was slightly modified as to size, and a short time later the original elliptical shell six-electrode furnace was built by American Bridge and installed at the Timken Plant. I believe that this has been the only successful six-electrode steel melting furnace ever used. The shell of elliptical shape has an inside long dimension of 29 ft. and a width of 20 ft. The hearth is relatively shallow, and it is arranged for charging through two doors by means of a charging machine of the open-hearth type. The unit is equipped with two 7500 KVA transformers.

In 1953, Mr. James K. Preston, of the Timken Roller Bearing Company, presented a paper at the Annual Electric Furnace Committee meeting of the A. I. M. E. His paper was entitled "Comparative Melting Rates of an Elliptical Six-electrode Furnace and a Circular Three-electrode Furnace." Mr. Preston's conclusions definitely indicated that melting time and bath oxidation were more rapid in the old elliptical unit than in a modern three-electrode furnace, and stated in his conclusions that "the reason for this appears to be a result of the better distribution of the radiant energy from the arcs."

The question now arises as to why this prototype six-electrode furnace has not been further developed and utilized. The probable answer to this question is the fact that with the use of the removable roof and higher transformer capacities, together with the availability of light scrap, the three-electrode furnace has been developed to the present capacities as a relatively efficient unit.

With a 24 ft. diameter shell three-electrode furnace and 35000 KVA transformer capacity, 24" electrodes are necessary. To provide movement for these electrodes, motors of 25 H. P. have been used. To control these motors, requires a motor generator set with driving motor capacity approximating 75 H. P. per electrode. If larger three-electrode furnaces are built with as much as 50000 KVA transformer capacity, still larger electrode sizes will be required. This in turn would require heavier electrode arms, with motor sizes necessarily increased.

To introduce 40000 KW from a 50000 KVA power transformer at an acceptable power factor would require relatively high secondary voltages. This increased voltage would in turn increase the length and configuration of the arcs. Problems of carrying the heavy current to the furnace would also be multiplied.

In the November issue of Carbon & Graphite News, one of the problems of utilizing power in electric furnaces has been ably outlined by Mr. W. E. Schwabe. The problem discussed by Mr. Schwabe relates to the introduction of equal amounts of energy at each electrode tip. Because of the inherent design of the bus and cable structure, the variation in impedance in the phases results in a variation of the amount of energy liberated at each arc. The unbalancing effect and its correction will be greatly magnified as current values are increased.

ADVANTAGES OF SIX-ELECTRODE FURNACE

If increased furnace holding capacities are to be used in the future, serious consideration should be given to the six-electrode unit. The advantages to be had from a six-electrode furnace as compared with a three-electrode furnace are as follows:

1. Six energy liberating areas would be had instead of three to better utilize the power available.
2. Lower secondary voltages and lower current values can be used, thus minimizing the problem of carrying the power to the furnace and liberating the energy uniformly.

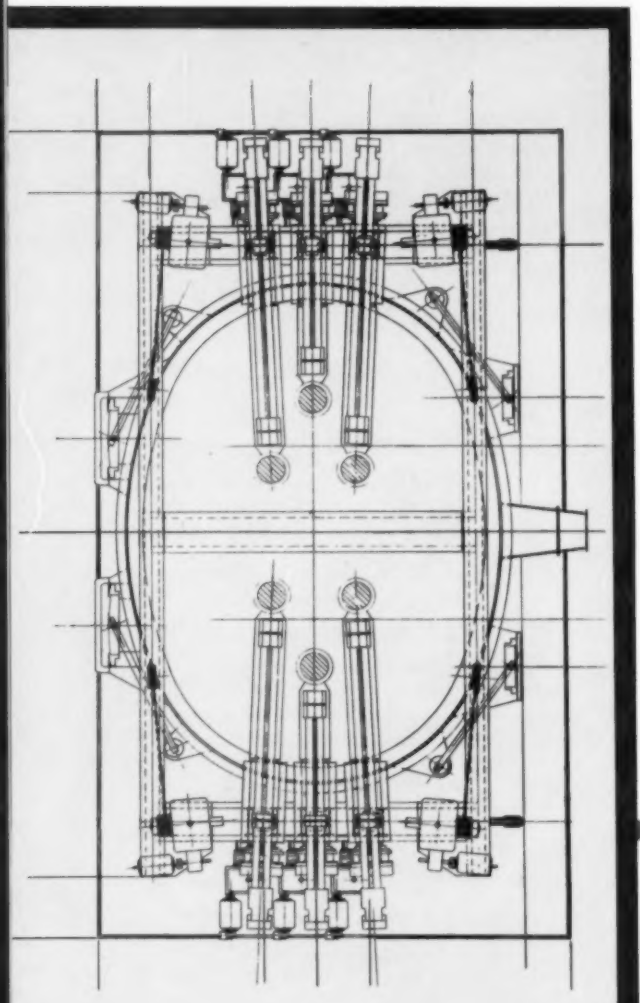
3. A six-electrode furnace with an elliptical shell will offer less difficulty of bottom and side wall maintenance. This is primarily due to the fact that the lateral spacing between front and back wall would be less than on an equivalent holding capacity three-electrode unit. Refractory losses would also be materially reduced, due to the fact that less heat will be radiated to the refractories from the bath, with a greater amount of the liberated energy absorbed by the charge. With increased refractory life, furnace down time will be less.
4. With smaller electrodes, as well as electrode holders and masts of less weight, electrode motor sizes are materially reduced. Therefore, more accurate electrode regulation can be obtained. Futhermore, the handling and servicing of smaller electrodes minimizes cost.

A BASIS FOR COMPARISON

As a means of comparing a large six-electrode furnace with a present day large three-electrode furnace, a preliminary design of a 250 ton holding capacity, six-electrode unit has been made. The shell of this furnace would be an ellipse with a dimension of approximately 35 ft. in length and 24 ft. in width. It would be equipped with two 25000 KVA transformers and would use two sets of three 20″ electrodes arranged in a similar way to the original six-electrode furnace (see cover illustration). The side frames would be connected together to form a gantry designed to carry the roof. The roof would be lifted and the gantry and roof moved out over the tapping side to permit charging. If two six-electrode furnaces were installed, a central transformer vault would house two of the transformers, with all of the switching equipment at the central location. On each opposite side, there would be a smaller transformer vault to house the additional transformers, panel and regulator.

Calculated data pertaining to a 250 ton holding capacity 35′0″ x 24′0″ six-electrode furnace equipped with two 25000 KVA transformers and using 20″ electrodes, is as follows:

1. Furnace to be initially charged with 125 tons of scrap and a 125 ton re-charge made.
2. 50000 KVA at 80% power factor, 40000 KW demand.
3. At 85% power-use factor* for melt, 34000 KW average power load.
4. Assume 400 KWH per ton required to melt scrap only.
5. 125 tons at 400 KWH per ton, 50000 KWH required to melt initial charge.
6. At 34000 KW average load, time required to melt initial charge, approximately 1 hour 28 minutes.



ESTIMATED HEAT CYCLE

(35′0″ x 24′0″ Six-Electrode Furnace, Ordinary Carbon Steels)

Fettle bottom		25 min.
First charge, 2 buckets, 62½ tons each		30 min.
Melt first charge	1 hr.	28 min.
Re-charge, 2 buckets, 62½ tons each		30 min.
Melt re-charge	1 hr.	28 min.
Refine & bring to temperature	1 hr.	0 min.
Tap		20 min.
TOTAL TIME		5 hrs. 41 min.

6 hour heats, or 4 heats per 24 hours for ordinary carbon steels

*The term power-use factor refers to the average amount of power that is normally used at a given power demand.

It is to be noted that an 85% power-use factor has been utilized in calculating the average KW power load during the melting period. It is highly probable that this power-use factor would be increased due to the relatively low amount of energy to be released at each electrode tip, and its more rapid absorption by the charge. Any increase in power-use factor would reduce the time of melt. The time required for bringing the bath to temperature and refining for ordinary carbon steels might also be reduced, and it is probable that more than 4 heats can be obtained in 24 hours.

In the above calculations, the use of oxygen has not been considered. If oxygen is used, the heat time will be materially reduced. On this basis, it is possible to produce 5 to 6 heats per 24 hours.

ESTIMATED ANNUAL PRODUCTION RATES

(Six-electrode 250 ton furnaces and three-electrode 180 ton furnaces)

Furnace availability 95% for average of 684 hours per month.

SIX-ELECTRODE FURNACE—50000 KVA

6 hour heats—250 tons per heat
41.6 tons per hour (conservatively estimated)
28,454 tons per month—341,448 tons per year per furnace

THREE-ELECTRODE FURNACE—35000 KVA

27.5 tons per hour (obtained with existing furnaces)
18,810 tons per month—225,720 tons per year per furnace

Two six-electrode 50000 KVA furnaces—approximately 680,000 tons per year
Three three-electrode 35000 KVA furnaces—approximately 675,000 tons per year

The production figures as outlined are for **comparative purposes only.** With modern transformers equipped with heat exchangers, overloads can be carried and together with the use of oxygen, average production in excess of 27.5 tons per hour of ordinary carbon steels can be obtained from the three-electrode 35000 KVA furnaces. This possibility of increased production holds true to an even greater extent when the six-electrode furnace is considered, for the reason that the increased power can be more readily utilized. With the use of oxygen and utilization of increased power, production in excess of 50 tons per hour can no doubt be obtained with the six-electrode furnace. It is possible with very light scrap that more than one re-charge may be necessary. This would apply to either the six-electrode or three-electrode furnace.

In the foregoing comparison of large six-electrode with large three-electrode furnaces, no consideration has been given to the use of high intensity gas burners to facilitate melting, nor has consideration been given to the use of hot metal. Based on existing practice, there is no question but that hot metal can be utilized as a part of the charge, perhaps as much as 50% of the charge. In the use of hot metal, the six-electrode furnace will have the advantage of better distribution of the energy without superheating portions of the bath.

COMPARISON OF POWER DEMAND

Three (3) 24'0", 35000 KVA three-electrode furnaces, two melting at 35000 KVA each, and one refining at 10000 KVA, with diversity factor of 85%, 68000 KVA demand.

Two (2) 35'0" x 24'0", 50000 KVA six-electrode furnaces, one melting at 50000 KVA, one refining at 15000 KVA, with diversity factor of 85%, 55250 KVA demand.

It may be said in connection with the two six-electrode 50000 KVA furnaces that a period could occur when both units would be melting. This same probability of melting times coinciding could also occur with three three-electrode 35000 KVA furnaces. In either case, the best operating pre-determined maximum demand would of necessity be utilized. This does not alter the fact, however, of an indicated lower power demand for the two six-electrode furnaces.

Comparison of Kilowatts of available and usable power per ton of charge during melt down

24'0" Furnace, 180 ton total heat, 90 ton charge

35000 KVA, 80% power factor, 28000 KW
90 ton initial charge, energy introduced per ton of charge, 310 KW
Energy introduced per ton of charge per electrode, 103.3 KW

35'0" x 24'0" Furnace, 250 ton total heat, 125 ton charge

50000 KVA, 80% power factor, 40000 KW
125 ton initial charge, energy introduced per ton of charge, 320 KW
Energy introduced per ton of charge per electrode, 53.3 KW

Overall Costs

As the energy to be liberated per electrode per ton of charge for the 50000 KVA six-electrode furnace is but slightly more than half of the energy which must be liberated per electrode per ton of charge for the 35000 KVA three-electrode furnace, it follows that the rate at which energy is to be absorbed by the charge at each electrode tip is also but slightly more than half. As this lesser amount of energy per electrode is more readily and more rapidly absorbed, it means that the full advantage of the existing available power can be obtained. This in turn increases furnace melting efficiency, decreases refractory deterioration and decreases the time required to melt.

COST COMPARISON

(2 six-electrode 50000 KVA furnaces with 3 three-electrode 35000 KVA furnaces)

Capital Costs

As to initial expense, it is estimated that two 50000 KVA six-electrode furnaces installed would not be far different in cost than if three 35000 KVA three-electrode furnaces were used. In connection with the shop, however, while the length of the building might be slightly reduced, larger ladle cranes would be required for the two six-electrode units as compared with the three three-electrode furnaces. These larger ladle cranes would, of course, entail a somewhat heavier building and slightly greater cost.

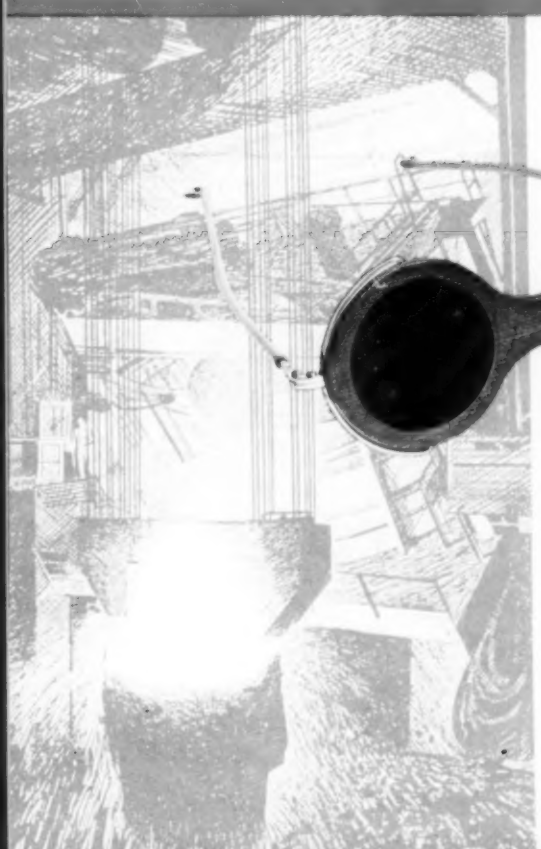
Operating Costs

Refractories: As previously mentioned, refractory costs for six-electrode furnaces should be materially less than for three-electrode units. This is primarily due to the better absorption of the energy by the scrap and lesser amounts of radiant heat reflected to the side walls and roof. Decreased refractory cost of 12% to 15% could, no doubt, be obtained.

Electrodes: Electrode consumption and electrode cost per ton of steel produced in two six-electrode furnaces will be approximately the same as that obtained with three three-electrode units.

Power: Because of the lower power demand required for two six-electrode furnaces, the cost per unit of power will probably be decreased over that which could be obtained in operating three three-electrode furnaces. This decrease may be 3% to 5% of the power cost.

Labor: Two six-electrode furnaces will require two crews per turn, and three three-electrode furnaces will require three crews per turn. Assuming direct furnace labor at 50% of the total furnace shop labor, there is indicated a saving of 16⅔% in labor cost.



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Makes any steel—any time—from stainless to plain carbon. Handles cold scrap, metallics, hot metal. Starts, stops quickly—gives faster melts.

Delivers highest quality product—
Closer temperature control possible.

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40% less than equivalent open-hearth capacity.

Saves space—
Savings of 25% and more vs. open hearths producing same tonnage.

Goes up fast—
Capital investment pays off sooner.

Uses clean fuel—electricity—
No combustion products to contaminate melt.

Cast Steel Harness

Overall Costs

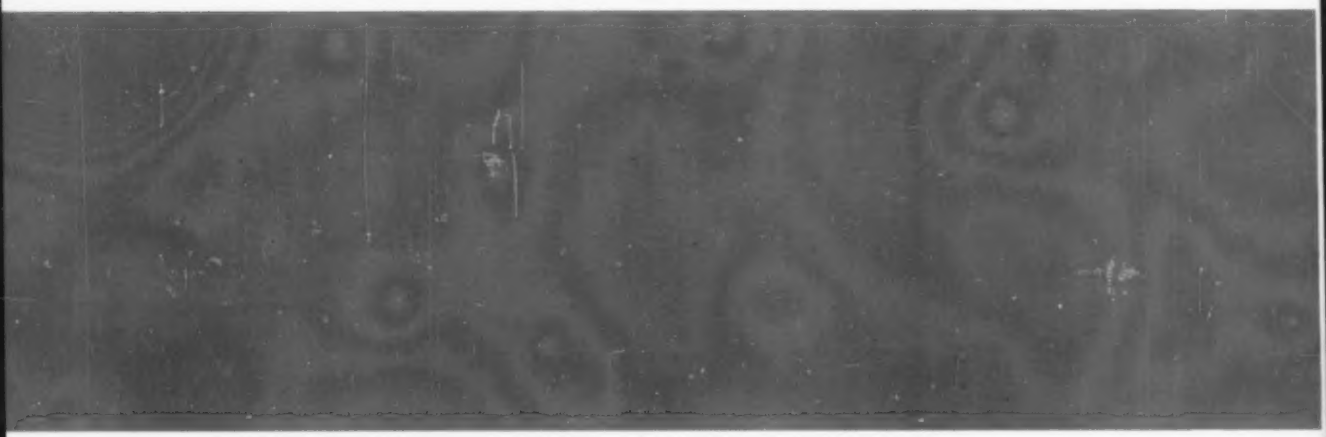
In combining amortization of capital cost with operating expense based on lower refractory cost, lower power cost, lower labor cost and equal electrode cost for the six-electrode furnaces, it is definitely indicated that two 50000 KVA six-electrode furnaces would show lower overall operating costs than three 35000 KVA three-electrode furnaces. It is entirely probable that this lower operating cost of the six-electrode furnaces could range up to $2.00 per ton of steel produced. On the basis, however, of only $1.00 per ton lower cost, there is indicated a saving of $680,000.00 per year on a yearly production of 680,000 tons. It is possible that a higher power-use factor than that previously outlined can be obtained with a six-electrode furnace. Oxygen can also be utilized. In both cases production would be increased and with increased production, greater savings would accrue.

FUTURE DESIGN OF ELECTRIC FURNACES

The six-electrode furnace that has been outlined as a 50000 KVA unit would have a nominal holding capacity of 250 tons and would use 20″ electrodes. Without modifying to any great extent the design of the present electrode system and use of power as now applied to existing three-electrode furnaces, a 300 ton 70000 KVA six-electrode furnace using 24″ electrodes could be built. It would also be possible to build a 50000 KVA approximately 250 ton holding capacity, three-electrode furnace using 30″ electrodes. In building these larger three-electrode furnaces, however, problems would be magnified relating to mechanical and electrical design, minimizing refractory losses, full utilization of power and operating difficulties. It is, therefore, definitely indicated that higher melting efficiencies and lower operating costs would be obtained with six-electrode furnaces.

CONCLUSIONS

Based on the progress of the past, there is no doubt that the production of electric furnace steel will increase at an ever expanding rate. To provide for this expansion and to produce electric furnace steel at reasonable cost, furnaces of greater capacity will be built. As higher efficiencies and resultant lower operating costs can undoubtedly be obtained with the use of large six-electrode furnaces as compared with the use of large three-electrode furnaces, the future development and use of the six-electrode furnace is to be expected.



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UNION CARBIDE

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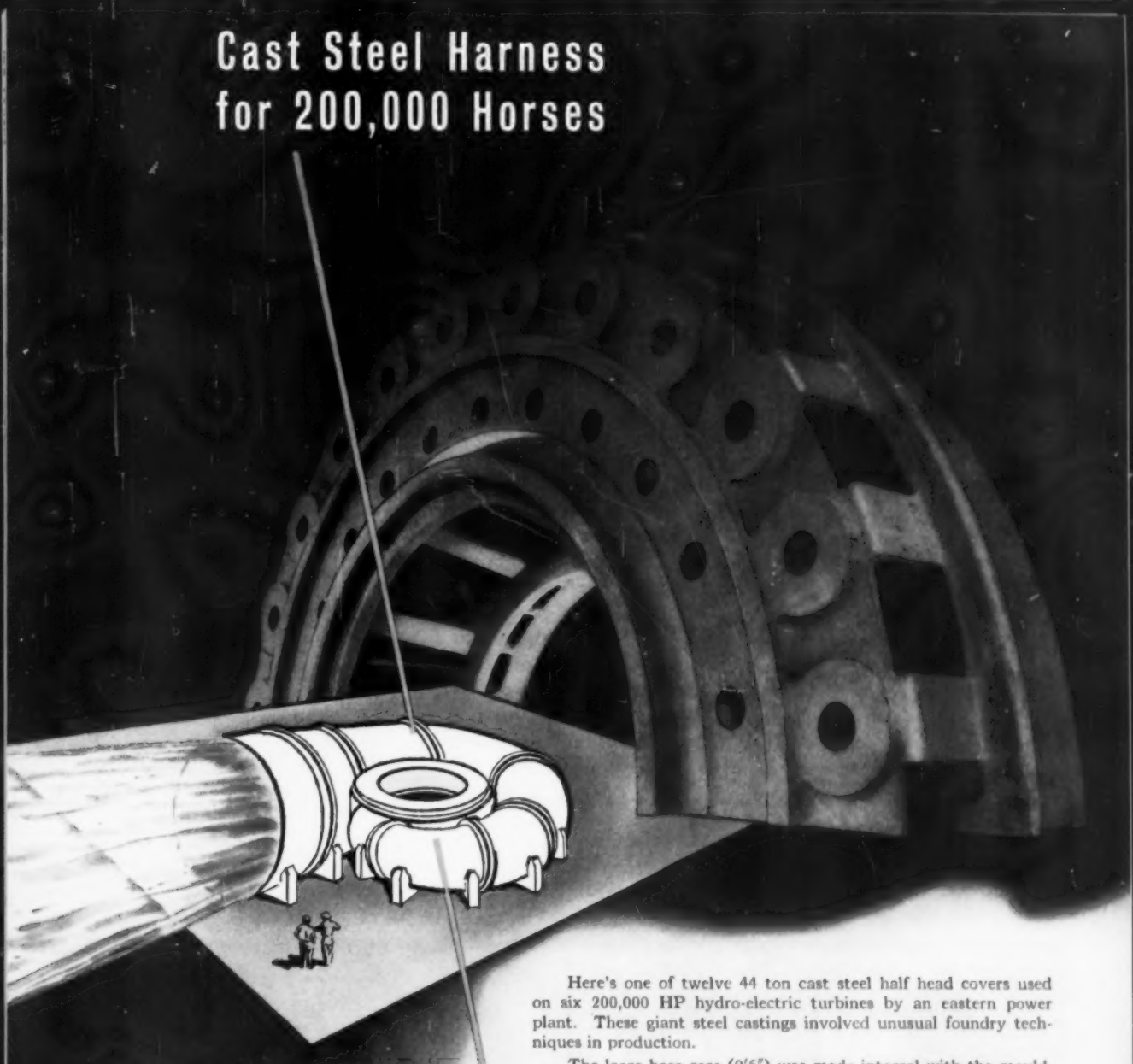
Cast Steel Harness for 200,000 Horses



SPECIFICATIONS	
Outside Diameter	23' 6"
Inside Diameter	9' 6" Bore
Height	3' 1¼"
Wt. of (Half) Head Cover	88,510 Lbs.
Wt. of Risers and Gates	93,000 Lbs.
Total Metal to Pour	181,510 Lbs.

Here's one of twelve 44 ton cast steel half head covers used on six 200,000 HP hydro-electric turbines by an eastern power plant. These giant steel castings involved unusual foundry techniques in production.

The large bore core (9'6") was made integral with the mould, eliminating handling and setting extremely large cores. A segmental type pattern with a ring type riser on the cope side eliminated the cope portion of the mould. Directional and progressive feeding of the molten metal during the solidification period was made possible by slight design modifications promoting a sound homogeneous structure.

After stripping, the castings were subjected to hydro-blasting and arc-air method for excavating surface imperfections. Finally, rigid dimensional inspection was followed by magnetic particle and radiographic examination at critical areas.

Here, at Erie Forge & Steel, experienced engineers, metallurgists and craftsmen control quality every step of the way from raw materials to finished steel casting. Consult with us on your steel casting and forging requirements.

•

ERIE FORGE & STEEL CORPORATION

ERIE, PENNSYLVANIA

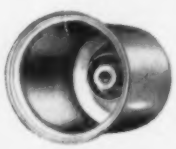
MUELLER BRASS CO. OFFERS 7 WAYS TO PRODUCE YOUR PART

Mueller Brass Co., because of its diversified manufacturing facilities that encompass a wide range of fabricating methods, is in the unique position of being able to offer you, the purchaser, an intelligent, unbiased analysis and recommendation of the best, most economical method by which your particular part can be produced. As the result of over 40 years' experience, the "Methods Analysis Department" has at its command complete knowledge of the advantages and limitations of each production process. After receiving detailed knowledge concerning the end use of the part, material specified, conditions under which it must operate and other pertinent factors, these analysis engineers make their recommendations. Every detail is considered. In many cases, methods analysis engineers recommend a simple design change that makes practical a much more economical method of production. This technical service, offered only by Mueller Brass Co., is given to each individual inquiry and is your assurance that you will get the best product at the best price . . . made the *one* best way . . . by Mueller Brass Co.

Send today for free technical literature on any one or all of the seven fabricating methods.

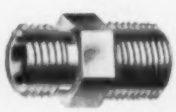
FORGINGS

Production equipment is available to produce press, hammer or cored forgings of any practical shape in sizes ranging from a few ounces to 150 lbs. in brass, bronze, aluminum and magnesium in 27 standard, as well as special, alloys.



COLD-PREST® IMPACT EXTRUSIONS

Mueller Brass Co. has complete machinery for producing Cold-Prest impact extrusions of aluminum, copper, brass, bronze and steel. Extrusions up to 28" in length are possible, depending on wall thickness and other design details. Parts can be designed having ribs, flutes, splines or bosses . . . with multiple wall diameters and with uniform or tapered wall sections.



SCREW MACHINE PRODUCTS

Mueller Brass Co. has one of the world's largest automatic screw machine departments fabricating both ferrous and non-ferrous custom parts. We can produce an infinite variety of shapes and sizes from ⅛" to 3¼" in wide range of free cutting and specialized alloys. Complete facilities for all secondary and finishing operations, as well.

POWDER METAL PARTS

Mueller Brass Co. can supply precision Sinteel® powder metal parts in wide range of sizes and metals at high production rate. Parts available from iron, brass and copper alloys. Parts may be ordered with such characteristics as self-lubrication, controlled porosity and good electrical and magnetic properties.

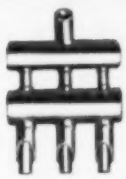
MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

MUELLER BRASS CO.

...and our methods analysis service helps you determine which is the best ...and most economical method

SAND CASTINGS

We specialize in the production of pressure-tight red brass castings. We utilize both metal match plate and wood patterns. Facilities include tool room and pattern shop, electric melting furnaces, high capacity core room and both bench and floor molding equipment to handle wide range of sizes.



FORMED COPPER TUBE

Mueller Brass Co. has modern facilities for forming seamless copper tube into a multitude of shapes. Forming methods used include bending, spinning, expanding or swedging, upsetting, flaring, flattening, beading and grooving, drilling and piercing, machining and joining. Formed copper tube coils are also available as single, double, spiral and serpentine shapes.

PLASTIC INJECTION MOLDING

Injection molding of plastic parts is still another process offered by the Mueller Brass Co. Parts are molded from such plastics as—nylon, polyethylenes, polyvinyl chloride, styrenes, linear acetal, chlorinated polyether, polycarbonates or polypropylene, dependent on part application.

MAN FROM MUELLER BRASS CO.

Since only Mueller Brass Co. can produce your part by all the methods, only the Man From Mueller Brass Co. can give sound advice on the one best method of production. Over 40 years of research, engineering, manufacturing and marketing experience stands behind him. When you are specifying and purchasing fabricated metal parts, call in the MAN FROM MUELLER BRASS CO.

271

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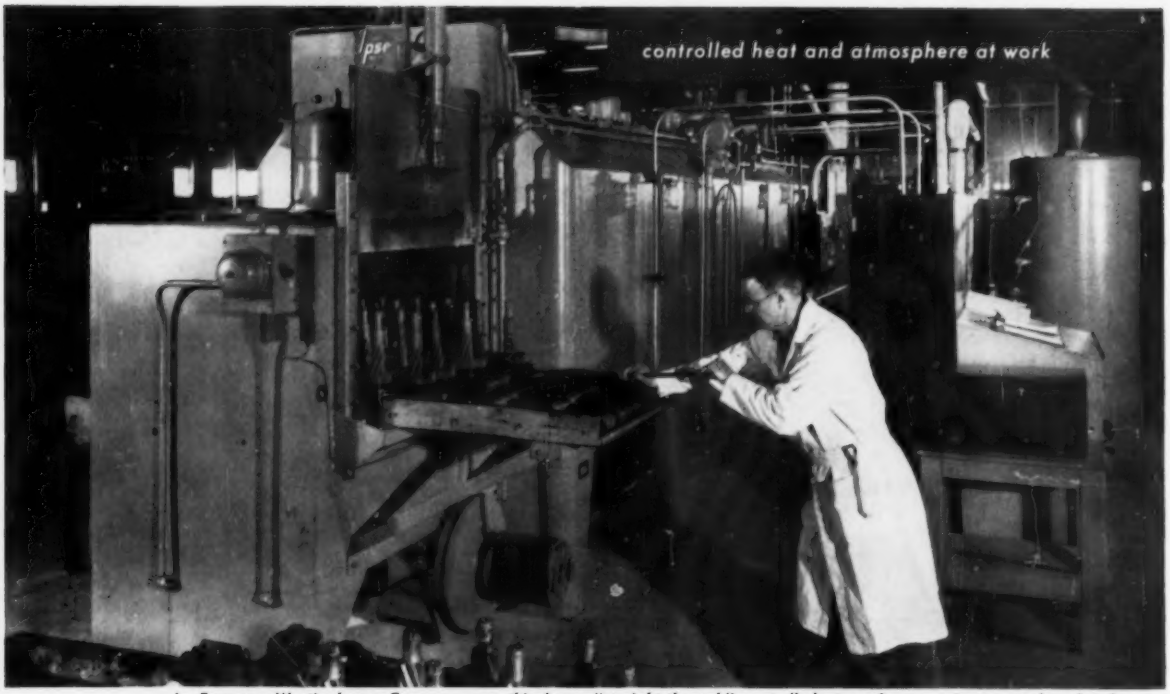

Le Tourneau-Westinghouse Company uses this Ipsen "straight-through" controlled atmosphere, semi-automated pusher furnace for hardening final drive gearing and transmission parts used in Le Tourneau-Westinghouse earth moving equipment.

"...we've increased production 25% and reduced costs with our Ipsen pusher heat treating units."

Le Tourneau-Westinghouse Company, Peoria, Illinois

Harold C. Stone is Chief Metallurgist of Le Tourneau-Westinghouse Company, Peoria, Illinois, one of America's leading producers of earth moving equipment. In the following interview, Mr. Stone tells why he is well satisfied with his Ipsen controlled atmosphere pusher heat treating equipment.

Q. What type of work do you run in your Ipsen "straight-through" controlled atmosphere heat treating unit?

A. We use our Ipsen pusher equipment for the controlled atmosphere hardening of final drive gearing, transmission parts, and other parts used in our Le Tourneau-Westinghouse earth moving equipment. Every 15 minutes the furnace receives a 200-lb. charge which remains in the furnace 90 minutes, and in the quench 10 minutes. If necessary, we can increase our charges to 500 lbs. and heat treat 2000 lbs. per hour.

Q. Have you been able to increase production with your Ipsen equipment?

A. We have achieved an approximate 25% increase with our Ipsen unit (as compared with the four salt pots it replaced). Part of this improvement is due to the fact that our work is pushed through the furnace work chambers, and quench, automatically. This, of course, is faster than would be possible if it had to be handled by our operators.

Q. What about your operating or production costs?

A. Fuel costs have definitely been reduced. Gas consumption with our Ipsen unit (including the generator) is less than 1,000 cfh... as compared with a total of 2,000 cfh for the four pot furnaces which turn out less work. Straightening, which was formerly required on about 80% of our parts with long shafts, has been virtually eliminated. And sand blasting is no longer necessary.

Q. What do you think of the automatic quench feature of your Ipsen equipment?

A. We like it because we can set the temperature of the quenching medium and maintain it. As a result, we obtain better quality and less distortion. We save labor by quenching batches instead of individual pieces.

Q. What about maintenance?

A. We haven't had any maintenance to speak of... only routine and preventive maintenance.

Q. Have your men commented on Ipsen equipment?

A. Yes. Our heat treat foreman, Mr. Waldo Dirkes, says it's one of the nicest pieces of equipment we have. He says the pusher furnace is simple to operate and certainly easy to keep clean.

Ask for your copy of a brochure describing the type of Ipsen equipment used by Le Tourneau-Westinghouse.

AUTOMATIC **Ipsen** HEAT TREATING UNITS

IPSEN INDUSTRIES, INC. • 723 S. MAIN STREET • ROCKFORD, ILLINOIS

Its balance makes the difference . . .

DOUBLE SIX M-2

HIGH SPEED STEEL

. . . a fully-uniform

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Steel

DOUBLE SIX M-2, now more than ever, is being used for hundreds of applications where its excellent balance of toughness, red hardness and wear resistance pays off in stellar performance of the tools and other products made from it.

Naturally, DESEGATIZED® Double Six M-2 is fully uniform—free of harmful carbide segregation even in the center areas of the bar you buy . . . and it's available in either regular analysis or XL® analysis for improved machinability.

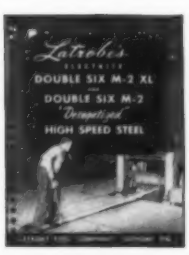
Metalmasters . . .

behind every bar of Latrobe High Speed Steel

- Electrite Double Six M-2*
- Electrite Crusader*
- Electrite Corsair*
- Electrite No. 1*
- Electrite Tatmo*
- Electrite Tatmo V
- Electrite TNW*
- Electrite Dynavan*

**Available in regular analysis or XL® analysis for improved machinability.*

Need better balance of properties for your high speed steel application? Call Latrobe today— ask for Double Six M-2!



Or, send for this booklet . . .

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MAIN OFFICE and PLANT: **LATROBE, PENNSYLVANIA**

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TESTING AT

3500°F

AND ONLY "LUKEWARM"

CREEP AND STRESS RUPTURE TESTING MACHINES

HYDRAULIC FATIGUE TESTING MACHINES

HYDRAULIC UNIVERSAL TESTING MACHINES

UNIVERSAL SCREW POWER TESTING MACHINES

As elevated temperature ranges continue to climb, needs are created for complete systems of equipment capable of testing physical properties of materials at high temperatures.

NOW — from *one* source, ready-to-operate systems incorporate all of these components:

1. **BASIC TESTING MACHINE**
2. **STRAIN MEASURING INSTRUMENTATION** for atmosphere, controlled atmosphere and vacuum furnaces
3. **COMPLETE HIGH TEMPERATURE ACCESSORIES** including furnaces, temperature controllers, vacuum pumps and complete related instrumentation.

With testing temperatures up to 3500°F currently available, Riehle engineers expect to announce a new range up to 4000°F in the near future.

For saving time on vital projects, rely on RIEHLE. Contact us regarding your requirements for physical testing at elevated temperatures.

Riehle TESTING MACHINES

A DIVISION OF

American Machine and Metals, Inc.

DEPT. MP-559, EAST MOLINE, ILLINOIS

APPLICATION and EQUIPMENT new products

Electronic-Vacuum Welding

High Vacuum Equipment Corp. has announced a production welder utilizing the concentrated energy of a focused beam of high-velocity electrons to weld metals. These new machines, which combine electronic and vacuum techniques, will be used to weld high-temperature reactive metals and superalloys. Model B-1520 Beamatron will weld tubing or parts up to 3⅛ in. in diameter and in lengths up

to 10 ft. A turntable can be installed for spot welding quantities of small parts. The vacuum chamber containing the electron gun and collet for rotating the work, is mounted on top of the cabinet. The vacuum pumping system is operated through a rotary sequence switch, which makes it impossible to open the vacuum valves in the wrong order. Positioning of the electron gun is accomplished by standard vacuum system remote controls.

For further information circle No. 922 on literature request card, page 48-D.

Strain Gages

A new line of strain gages developed for use on magnesium parts has been announced by Tatnall Measuring Systems Co. Principal applications of the C15 gage is in the airframe and guided-missile manufacturing industry. The gages may be used to stress analyze such structures as fuselages, wing components, stabilizing fins and missile bodies. The new gages provide a low coefficient of resistance when mounted on such material as magnesium which has a thermal expansion coefficient of approximately 15 ppm. per degree Fahrenheit. The 101 series measures strain from subzero temperatures to approximately 200° F. and the 100 series to 500° F.

For further information circle No. 923 on literature request card, page 48-D.

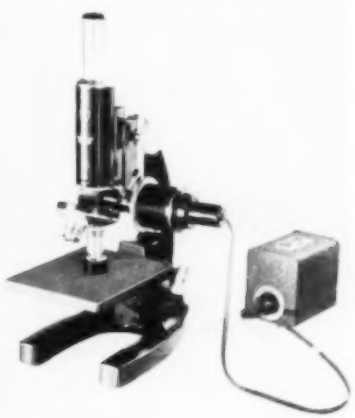
Molybdenum Powder

A new process for the production of molybdenum metal powder by a single-stage reduction of molybdenum oxide at high temperatures has been announced by Metals and Residues, Inc. Because of its extreme volatility, molybdenum oxide is at present principally reduced in two stages—first to brown oxide at 750 to 950° F. and then to metal at 1800 to 1900° F. The single-stage reduction process increases the rate of molybdenum powder production over the rates obtainable by current practices.

For further information circle No. 924 on literature request card, page 48-D.

Metallurgical Microscope

Bausch & Lomb Optical Co. has announced a new line of low-cost metallurgical microscopes for routine applications. The fine adjustment knob is located a short distance above the table top, allowing the arm to rest in a natural position. The instruments feature full-sized control knobs. All objectives are parfocal and centered in a revolving nosepiece which adjusts automatically for wear. Microscopes

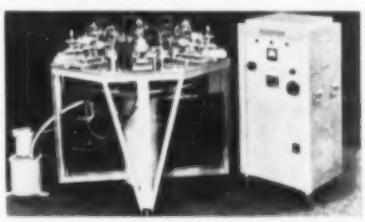


are portable for on-the-spot examination and analysis.

For further information circle No. 925 on literature request card, page 48-D.

Ultrasonic Machining

A new ultrasonic machine tool which will machine hard and brittle materials such as germanium, silicon and ferrite has been announced by the Sheffield Corp. It has eight horizontal machining stations arranged in a circle on a waist-high table, 4½ ft. in diameter. The eight machining stations can be operated simultaneously or independently. Each machining station accommodates a cutting tool up to 1.08 in. in diameter, machining workpieces to 0.050-in. depth. Extended-type ultrasonic tooling delivers high-frequency mechanical energy



from the transducer located in a well in the work table through a curved cylindrical rod to cutting stations.

For further information circle No. 926 on literature request card, page 48-D.

Vacuum Metallizing

A new bell-jar metallizing unit has been announced by NRC Equipment Corp. It will be used for production, research and development of such products as improved semiconductors, precision resistors and capacitors, printed circuits, wave guides, computer elements and many others. All elements are contained in the 3 by 4-ft. cabinet. The vacuum chamber is formed by a 30½-in.-high bell jar and a 28-in.-diam. baseplate. The baseplate has one central vacuum pumping port and 17 holes for feed-throughs. Four filament posts are mounted on power feed-throughs rated at 6 volts, 125 amp.; three high-voltage or power feed-throughs are

Lincoln

WELDYNAMICS

NEWS ABOUT ARC WELDING AT WORK CUTTING COSTS

Better quality, lower cost when Lincoln mild steel wire and alloy fluxes are used on high pressure pipe.

HOW FLORI PIPE CONTROLS QUALITY AND COSTS . . . MEETS DELIVERY DEADLINES

Keeping quality up, costs down and still maintaining delivery of prefabricated pipe sections is a tough job for anyone. But even on such vast piping jobs as Tidewater Oil Company's Delaware refinery it is all in a day's work to the Flori Pipe Company of St. Louis, Missouri. Flori is one of the nation's leading fabricators of high pressure pipe for the petroleum and petro-chemical industry.

Flori's Welding Engineer is Ken Notvest. He is responsible not only for welding methods and procedures; but also for maintaining the high degree of welding quality required on the special alloy pipe work in which Flori specializes.

Jetweld LH-70 gives 99% X-ray acceptance.

Mr. Notvest has developed some excellent procedures for manual welds. He uses Fleetweld 5-P, a Lincoln E-6010 electrode, for root beads in carbon steel pipe and follows with Jetweld LH-70, a low hydrogen E-7018, for cover passes. This gives them 99% X-ray acceptance on open gap welds without backing rings.

After testing many different electrodes for this application Mr. Notvest believes Jetweld LH-70 to be superior for deposition rate, appearance, out-of-position welding, and as-welded low temperature impact strength.

Flori also has many automatic submerged arc welding applications in their pipe fabricating plant. They once welded alloy pipe with alloy wire and neutral flux. However, as a result of a survey conducted in the plant by John Lucas, a Lincoln welding engineer, they have found that Lincoln alloy fluxes (mixed especially for them), and mild steel wire cut material costs by two-thirds—cut welding time in half and make better welds.

Mr. Notvest claimed, "When we invited the Lincoln man to survey our operations we had no idea that the result would make such substantial savings."

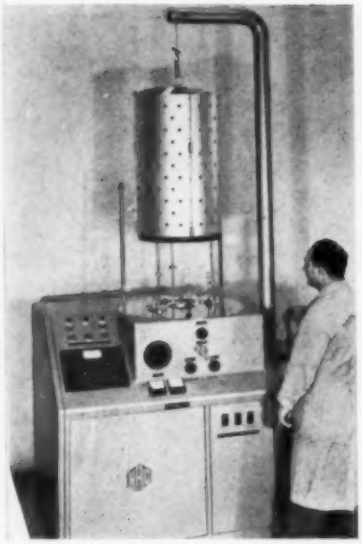
For cost reduction ideas and help with procedures, call your Lincoln welding engineer today.

Ken Notvest, Flori's Welding Engineer, examines a weld from the inside with the "Bore Scope" he designed and built.

The LINCOLN ELECTRIC CO.

Dept. 1300 • Cleveland 17, Ohio

The World's Largest Manufacturer of Arc Welding Equipment

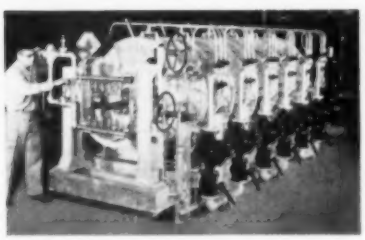


rated either at 400 volts, 10 ma. or 115 volts, 10 amp.; four other feedthroughs hold work support posts and the remaining six are spares.

For further information circle No. 927 on literature request card, page 48-D.

Annealing Tubing

A continuous furnace line which will simultaneously anneal three strands of stainless steel tubing has been announced by Selas Corp. of America. The six-barrel furnace line is 15½ ft.



in overall length and can accommodate tubing from ⅝ to 5 in. O.D. Automatic temperature control is in three zones, to deliver tubing at 2100° F. to the quench bath located at the discharge end.

For further information circle No. 928 on literature request card, page 48-D.

Heat-Resisting Alloy

An air-hardening specialty steel with high strength at elevated temperatures has been announced by Latrobe Steel Co. The alloy resists softening upon continued exposure to temperatures up to 1000° F. while providing high toughness and ductility at tensile strength levels up to 300,000 psi. Dynaflex is air-hardened to full hardness even in large sections. It can be formed, worked and welded. It has relatively low coefficient of thermal expansion, better than average corrosion and oxidation resistance, and low strategic alloy content.

For further information circle No. 929 on literature request card, page 48-D.

Continuous Casting of Aluminum Strip

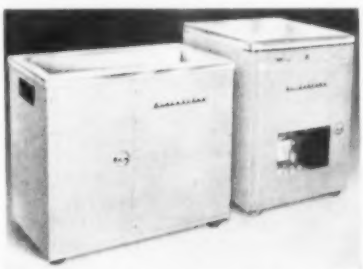
A new machine for the continuous casting of aluminum and aluminum alloy strip has been announced by Lobeck Casting Processes, Inc. It was developed to produce narrow-width aluminum strip in such fields as impact extrusions, roll-formed sections, electric lamp bases, awnings, venetian blinds and containers. Casting is done under a 5-ft. diam. wheel with a trough-shaped groove along its circumference. The depth and width of the groove determine the size of the slab to be cast. The casting wheel is water cooled so that the liquid metal is fully solidified during its travel

along the wheel circumference. Hot rolling, cooling, cold rolling, gaging, shearing and coiling complete the process. Aluminum alloy strip ⅛ by 8 in. is produced in coils 16 in. I.D. by 50 in. O.D. by 1300 lb. at a continuous rate of about 4 tons per hour.

For further information circle No. 930 on literature request card, page 48-D.

Ultrasonic Cleaning

New ultrasonic cleaning equipment has been announced by Blackstone Corp. The electronic generator is separately housed in a cabinet 25 by 25

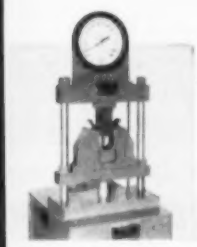


by 33 in. The cleaning tank is 30 by 12 by 12 in. Cleaning solution is activated by four multi-element transducers constructed from over 1000 magnetostrictive strips operating at 20 kc. per sec. Transducers are air cooled and will not overheat low-

will any of these tests help you?

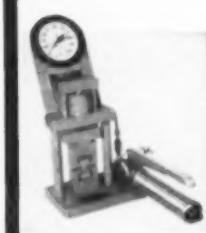
is your problem like this?

Steel City versatile Brinell Hardness Tester checks hardness of automotive crankshafts. One fixture adjustable for four different sizes of shaft. Fixture easily removable to provide standard tester with 12" x 18" opening . . . large table anvil for multitude of testing.



... or more like this?

Steel City Guided Bend Testing Machine makes qualification tests on butt-welded specimens in accordance with AWS and ASME standards. Exclusive design provides automatic ejection of tested part. Unskilled operator makes perfect test.



... or *different* entirely?

Steel City Tensile Tester (hydraulic, hand operated) determines strength of graphite samples. Self-contained unit simplifies tensile testing operation, releases more expensive equipment for other work. Adaptable for powdered metal, other specimens.

Whatever your testing problem

Steel City may *already* have a practical solution.

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Cedar Rapids: McKesson & Robbins, Inc., 900 2nd St., S. E.
Davenport: Roederer Transfer & Storage Co., 513 Fillmore St.
Des Moines: Blue Line Storage Co., 226 Elm St.
Ottumwa: J. W. Edgerly & Co., 129 W. Main St.
Sioux City: McKesson & Robbins, Inc., 308 Pearl St.

KANSAS
Wichita: Reid Supply Co., 306 W. 2nd St.

KENTUCKY
Henderson: P. B. & S. Chemical Co., 1100 N. Adams St.
Louisville: Griffin Chemical Co., 528 Franklin St.

LOUISIANA
New Orleans: Joseph Jurisich Warehouse, 338 No. Peters St.
Sam Reisfeld & Son, 649 So. Galvez St.
Shreveport: Thompson-Hayward Chemical Co., 219 Beech St.

MAINE
Portland: Acme Engineering Co., 46 Market St.

MARYLAND
Baltimore: Leidy Chemicals Corp., 920 S. Eutaw St.

MASSACHUSETTS
Attleboro: Reynolds & Markman, Inc., 88 Union St.
Malden: Barrett Div., Allied Chemical Corp., 378 Commercial St.
Springfield: The Chemical Corp., 54 Waltham Ave.
West Springfield: Barker Chemical Co., 101 Circuit Ave., P.O. Box 173
Worcester: Brewer & Company, Inc., Ind. Chem. Div., 45 Arctic St.
Chemical Sales & Service Co., Inc., 45-61 Fremont St.

MICHIGAN
Detroit: Barrett Div., Allied Chemical Corp., 1200 Zug Island Rd.
Eaton Chemical & Dyestuff Co., 1490 Franklin St.

MINNESOTA
Duluth: Northern Cold Storage & Warehouse Co.
St. Paul: Lyon Chemicals, Inc., 2305 Hampden Ave.

MISSISSIPPI
Jackson: Ricks Storage Co., 126 Ricks St.

MISSOURI
Joplin: P. G. Walker & Son, Inc., 702 Pennsylvania Ave.
Kansas City: Abner Hood Chemical Co., 507-517 N. Montgall Ave.
Thompson-Hayward Chemical Co., 2915 Southwest Blvd.
Springfield: P. G. Walker & Son, Inc., 1425 College St.
St. Louis: McKesson & Robbins, Inc., 904 Landreth Bldg., 320 No. Fourth St.
Nitrogen Div., Allied Chemical Corp., 4528 South Broadway
G. S. Robins & Co., 126 Chouteau Ave.

NEBRASKA
Omaha: McKesson & Robbins, Inc., Chemical Dept., 605 Leavenworth St.

NEW JERSEY
East Paterson: Aetna Color & Chemical Co. Inc., 60 Linden Ave.
Edgewater: Nitrogen Div., Allied Chemical Corp., 1 River Rd.
Paterson: Lotte Chemical Corp., 109 - 5th Ave., P.O. Box 2488
Seaboard Industries, 195 Keen St.

NEW YORK
Albany: Albany Laboratories, Inc., 67 Howard St.
Brooklyn: Engel's Trucking Co., 541 Kent Ave.
Tex-Ite Products Corp., 555 Park Ave.
Buffalo: Commercial Chemicals, Inc., 211 Hertel Ave.
East Syracuse: Gleason Chemical & Supply Co., Inc., 130 Headson Drive
Mt. Vernon: Eastern Supply Co., 521 East Third St.
New York: Davies Nitrate Co., 114 Liberty St.
N. H. Heyman, Inc., 168 East 91st St.
Nitrogen Div., Allied Chemical Corp., 40 Rector St.
E. M. Sargent Pulp & Chemical Co., Inc., 7 Dey St.
Poughkeepsie: Duso Chemical Co., Inc., Fulton & Fairview Sts., P.O. Box 665
Rochester: William B. Duffy Carting Co., 62 Scio St.

NORTH CAROLINA
Charlotte: Acme Soap & Chemical Co., Inc., Pineville Rd., P.O. Box 11,264

OHIO
Cincinnati: Merchants Chemical Co., Inc., 2933 Spring Grove Ave.
Cleveland: The Conaty Warehouse Co., 1245 Hemlock St.
The Harshaw Chemical Co., 1945 E. 97th St.
Columbus: Merchants Chemical Co., Inc., 1795 South High St.
Toledo: Inland Chemical & Solvent Corp., 1175 Dorr St.

OKLAHOMA
Oklahoma City: Rex Engineering & Sales Co., 2735 N.W. 10th St., P.O. Box 5141
Tulsa: Vaughn Chemical Co., 1102 E. 3rd St.

PENNSYLVANIA
Altoona: Western Pennsylvania Chemical Co., Inc., 4125-41 6th Ave., P.O. Box 703
Avoca: Lunox Chemical Works, Inc., Box 7
Erie: Western Pennsylvania Chemical Co., Inc., 2001 W. 12th St.
Middletown: Western Pennsylvania Chemical Co., Inc., Brown & Catherine Sts.
Philadelphia: Barrett Div., Allied Chemical Corp., 30th St. & Gray's Ferry Rd.
Hugh F. Gannon Trucking Corp., 430 N. Front
Pittsburgh: Thomas Knoch, 244 Bascom St.
Pitt-Penn Terminal Co. 1320 Penn Ave.

RHODE ISLAND
Providence: T. H. Baylis Co., 42 Gano St.

SOUTH CAROLINA
Charleston: Thomas W. Carroll, Inc., 24 Market St.

TENNESSEE
Memphis: The Lilly Co., 466 Union Ave.
Nashville: Cumberland Storage & Whse. Co., 124 1st Ave., N.

TEXAS
Big Spring: T & T Supply Co. Inc., 1308 E. 3rd St.
Dallas: Alford Refrigerated Warehouse, 318 Cadiz St.
P.O. Box 5088
Chas. H. Platter & Co., Suite 228, 318 Cadiz St.
El Paso: George S. Thompson Co., Inc., 611-615 No. Campbell St.
Harlingen: Jones Moving & Storage Co., 1002 W. Jackson
Houston: Leatherwood Supply Co., 2005 McKinney
Lubbock: Thompson-Hayward Chemical Co., P.O. Box 323
San Antonio: Ryan Brokerage, Co., Transit Tower
Scobey Fireproof Storage Co., 315 N. Medina

VERMONT
Burlington: Valcour Chemical Co., Inc., Ft. So. Champlain St.

VIRGINIA
Richmond: Phipps & Bird, Inc., 303 South 6th St., P.O. Box 2-V

WEST VIRGINIA
Charleston: B. Preiser Co., Inc., 416 W. Washington St., P.O. Box 6118

WISCONSIN
Chippewa Falls: Lyon Chemicals, Inc., 201 E. Walnut St.
Cottage Grove: North Central Chemicals, Inc.
Green Bay: Wisconsin Refrigeration Supply Co., 1016 Velp Ave.
Milwaukee: Benlo Chemicals, 1907 - 25 South 89th St.

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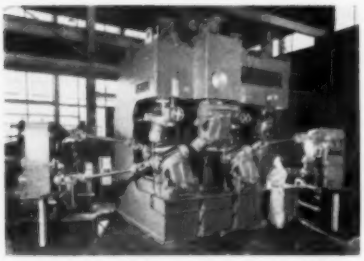
Dept. CA 8-16-1, 40 Rector Street, New York 6, N.Y.

boiling, low-flash, flammable or toxic solvents. It is possible to use solvents at temperatures to 400° F.

For further information circle No. 931 on literature request card, page 48-D.

Straightening Machine

A new multicycle tube straightening machine built to straighten large-diameter thin-wall steel tubing that will be subjected to underground service has been announced by Blaw-Knox



Co. The machine uses no guides to maintain true circular cross section of the workpiece during straightening. It is equipped with four driven rolls for balanced turning torque around the workpiece. It features a cluster of three rolls (two driven) at the input end; a twin roll bending stand keeps the pipe from ovaling at the point of greatest load. Another cluster of three rolls (two driven) and a single bending roll at the exit end complete the double straightening cycle. Pressure exerted by the two clusters is positively limited by a pneumatic pressure equalizing device. The straightener shown will handle tubing from 3 to 9⅝ in. in diameter.

For further information circle No. 932 on literature request card, page 48-D.

Agitator

A steam jet agitator for batch pickling of sheets, coiled rods, wire and other products has been announced by Heil Process Equipment Corp. The equipment consists of a tree-shaped arrangement of lead piping. A vertical section fitted with a flange connects to an 80-psi. steam line outside the tank. Impervious graphite nozzles are set in the crossarms at spaced intervals to assure uniform heating and agitation. Steam jet agitators are available in various lengths and widths to meet the requirements of any batch pickling tank.

For further information circle No. 933 on literature request card, page 48-D.

Portable X-Ray

An industrial X-ray generator weighing 50 lb. and small enough to pass through a 6-in. opening but powerful enough to radiograph 1¼ in. of steel in 45 sec. has been announced by Picker X-Ray Corp. The Andrex 140 consists of two parts—the 50-lb. generator and the 55-lb. control. Meters and stepless controls permit constant monitoring during each exposure to prevent the necessity of retakes due to line voltage fluctuations or other variable factors.

For further information circle No. 934 on literature request card, page 48-D.

Dryers

C. I. Hayes, Inc., has announced the expansion of their Molecu-Dryer line to include both smaller and

larger capacity models ranging from 250 to 6000 cfh. These units utilize superinduced conduction to obtain continuous operation without the use of blowers, heat exchangers, or separate purge gases. Molecu-Dryer design permits high temperature drying to dew points of –100° F.

For further information circle No. 935 on literature request card, page 48-D.

Tool Steel

Brown & Sharpe Mfg. Co. has announced a new air-hardening precision-ground tool steel which is precolored maroon. It is rust resistant and requires no greasing or degreasing. Color does not affect its heat

WORD FROM Waukee...

MAN FROM PORTLAND

It is a joy for this writer to visit New England to call on our customers there. And it is a pleasure to travel with George Chutter who looks after Waukee customers throughout New England and Eastern New York State.

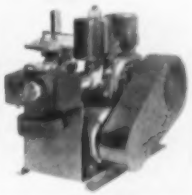
George, a native New Englander, is an M.I.T. graduate — and a prouder or more faithful alumnus would be hard to come by. George not only is a fine engineer — but an outstanding salesman with a deep and abiding sense of customer service. He travels 50,000 miles a year to see that his customers are properly cared for. In addition thereto — he knows every good eating place in New England.

George and his wife, Marion, live in Portland, Connecticut, and they are mighty proud of their three fine boys — one an engineer with Procter & Gamble, the middle boy a dentist at Manchester, Conn., and the youngest at Worcester Polytechnic.

We at the Waukee Factory are mighty proud and grateful that the interests of Waukee's New England customers are in such careful and capable hands.

HELPFUL BULLETIN ON GAS-AIR MIXORS

Bulletin 420 on Waukee Type "R" Mixors lists capacities of mixors by both endothermic and exothermic outputs and, in addition, provides tables showing Flo-Meter selections to go with each application for city gas, natural, mixed 800 BTU, propane, and butane. Included also are dimension tables. You will find this information mighty handy and a great time-saver in selecting mixing equipment and Flo-Meters to go with it. For your copy write Waukee Engineering Company, 5140 North 35th Street, Milwaukee 9, Wisconsin.



R. C. O.

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GAS-AIR MIXORS
ROTARY-VANE COMPRESSORS
INDUSTRIAL WASHING MACHINES

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by eddy currents and magnetic fields

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They are sold under the name

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Listed below are only a few of these instruments. You may like additional information or facts for exploration, together with some knowledge of their present uses. Write for data sheets on any of the Magnatest instruments mentioned. Also, we have numerous technical translations on eddy current work that we can supply to you. Tell us briefly your possible application—or ask to have a Magnaflux Engineer discuss it with you.

MAGNATEST ED-500
Crack Detector and Sorting Unit
A probe type eddy current meter. Detects and measures relative depth of cracks . . . sorts ferrous and nonferrous metals according to hardness, heat treat condition or alloy . . . compares relative electrical conductivity . . . may be used to "measure" coatings, sheet or film thickness.

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MAGNATEST FM-201
Magnetic Field Meter
A precision magnetic field meter for making extremely accurate and sensitive measurements of DC magnetic fields. Used for many geophysical applications, in magnetic investigations and testing of magnetic metals.

MAGNATEST FW-400
Rod, Tube and Wire Testing Units
For testing nonmagnetic rod, tube and wire. Detects laps, seams, inclusions, voids, concentrated porosity, embrittled areas, "slivers" at mill speeds. Oscilloscope indicates presence of defects. Adjustable for pre-determined requirements, automatic marking or rejection.

MAGNATEST FM-500—Elastomat
Provides a convenient means for rapid, accurate measurements of the moduli (elasticity and shear) and damping factor of materials. Torsional as well as longitudinal and flexural moduli can be evaluated. Rapid measurements may be made on practically any solid material.

MAGNATEST FS-300
Magnetic Sorting Instrument
Detects changes in alloy composition, heat treat conditions . . . depth of case . . . carbon content . . . tensile strength and cold working. Also detects and measures change in mass and dimension. For use on magnetic metals. Fully automatic, if desired.

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ZYGLO for nonmagnetic materials, locates cracks and pores.

SONIZON Ultrasonic Testing of thickness, laminar defects.

STRESSCOAT to find and measure high stress areas.

PARTEK to test unfired ceramics and powder metal parts.

STATIFLUX for locating defects in glass, porcelain, and non-metal coatings.

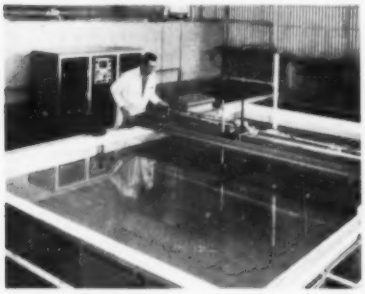
FULL INFORMATION OR CONSULTATION AT YOUR REQUEST

treatment. Available in about 250 sizes from ⅛ by 1 in. to 18-in. lengths, air-hardening stock is used for dies, gages, machine parts, shear blades, knurling tools and taps. Its wearing qualities are midway between high-carbon, high-chromium steels and manganese oil-hardening steels.

For further information circle No. 936 on literature request card, page 48-D.

Ultrasonics

Ultrasonic Testing and Research Laboratory has announced a new ultrasonic recording system for bond testing and flaw detection of brazed

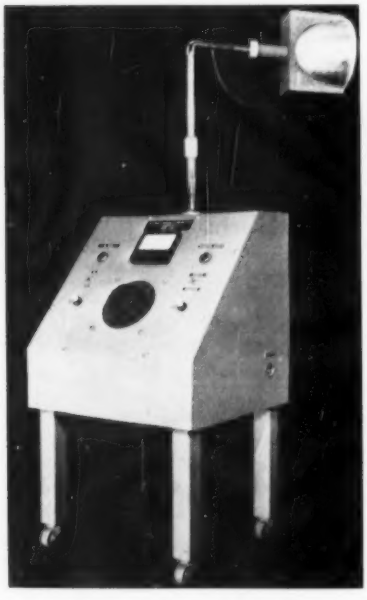


joints and adhesive bonded structures. One-to-one scale recordings can be made of areas 18 in. wide and of indefinite length.

For further information circle No. 937 on literature request card, page 48-D.

Heater

A new elliptical radiant energy heater for X-ray diffraction, hot stage microscopy, permeability studies, zone refining and for specimen heating during mechanical testing has been announced by Materials Research Corp. It is capable of locally heating



a specimen to 1600° F. A combination of two lamps has developed temperatures to 2000° F. No electrical or mechanical interaction may occur with either the specimen or surroundings. It may also be used to heat an encapsulated specimen. The lamp controls are mounted on a mobile stand.

For further information circle No. 938 on literature request card, page 48-D.

Ferroalloys

Vanadium Corp. of America has announced three new exothermic ferroalloys. The list of exothermic alloys now includes exothermic ferrochromium, available with different carbon contents; exothermic ferrosilicon; exothermic ferrochromium-silicon; exothermic ferrovanadium; exothermic ferrocolumbium. The exothermicity of these alloys permits addition of alloy content to the molten metal without chilling effect.

For further information circle No. 939 on literature request card, page 48-D.

Vacuum Gage

A new vacuum gage having sensitivity in two ranges, from 1 to 100 microns and from 1 micron to 500

mm., has been announced by Consolidated Electrodynamics Corp. This thermal-type gage is available with one to four stations. The gage's sensing tube combines a tungsten filament and all-metal construction.

For further information circle No. 940 on literature request card, page 48-D.

Cleaner

A new formulation for Etchalume 14, an etching and cleaning compound for aluminum, has been announced by Enthone, Inc. Etchalume 14 is a powdered material which is added to water and can be used over a wide range of concentrations and temperatures. It contains complexing agents which cause aluminum dissolved in the bath to precipitate as a loose, flocculent powder.

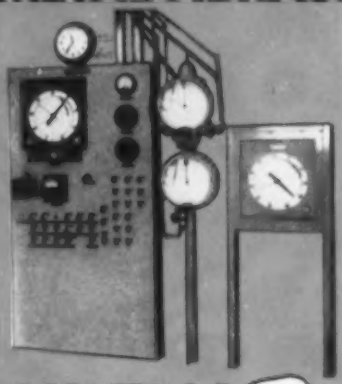
For further information circle No. 941 on literature request card, page 48-D.

Spot Welding

A new Heliarc spot welding machine which is tape controlled has

Now!

METAL ABRASIVE



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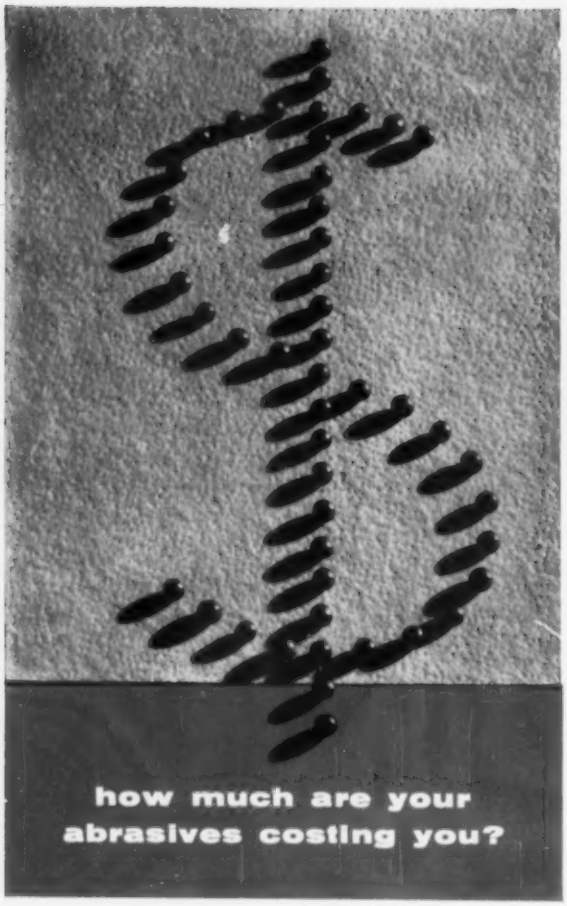

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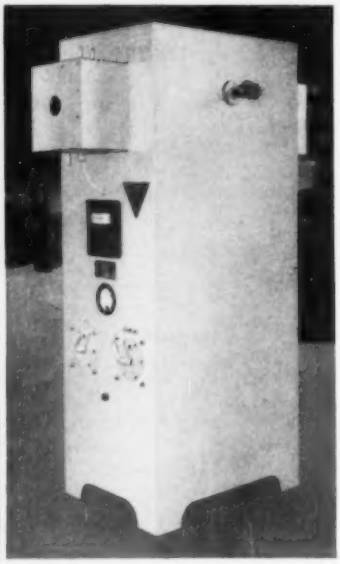
PERECO
ELECTRIC TUBE FURNACES
for LABORATORY WORK
requiring close control of temperatures to 2800° F.



- Tubular globar heating elements in lengths up to 60 inches (12" I.D. Max.)
- Water-cooled terminals
- Precision temperature controls for wide range control and turndown
- Designed for either normal or extremely rapid heat-up
- Cabinet or trunion mounted horizontal to vertical (90°) swing.

Tubular Silicon-Carbide Elements—Cabinet or Trunion Mounted

Pereco Electric Tube Furnaces are available with many modifications for meeting individual types of investigations or laboratory control and process work. Units illustrated above incorporate hollow silicon-carbide heating elements (2" I.D.) that can be any length, in 2" increments, up to 60". For work requiring larger tube dimensions, units can be furnished utilizing a ceramic tube surrounded by a number of solid ("AT"-type) silicon-carbide heating elements with air-cooled terminals. To quickly determine if a Pereco Tube Furnace might be "your better answer" tell us about your work requirements. No obligation.

Upper Left:— Model MT 30 x 2

Above:— Model MT 30 x 2-T

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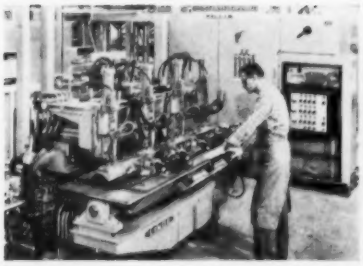


been announced by Linde Co. This machine requires access to only one side of the joint to be welded. Welds are produced by a tungsten electric arc, shielded by inert argon gas. Heliarc spot welding uses positive and instantaneous arc ignition. The unit pictured above makes 2520 spot welds an hour.

For further information circle No. 942 on literature request card, page 48-D.

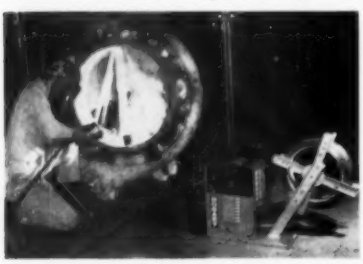
Titanium Sheet

Mallory-Sharon Metals Corp. has announced expanded titanium sheet for use in the plating and chemical industries. The expanded sheet will be available in gages from 0.050 to 0.125 in. into ½ to 1½-in. diamonds, in standard 48 by 96 in. sheets. It can be bent over a radius four times the metal thickness in either the longitudinal or transverse direction after sandblasting and pickling. Expanded sheet will be available in unflattened or flattened mesh.

For further information circle No. 943 on literature request card, page 48-D.

Welder

A portable semiautomatic welder designed for either open-arc hard surfacing or submerged-arc welding has been announced by Hobart Bros. Co. The unit features a wire feeder designed for hard surfacing, buildup and mild steel welding using tubular wires or solid wires. It may be connected to almost any welding ma-



chine, either a.c. or d.c. The unit is designed for use with continuous current up to 500 amp. using the flux-type or open-arc gun. The wire-speed range, at nominal 30 volts, is 60 to 260 in. per min.; an optional gearbox provides 90 to 460 in. per min. at nominal 30 volts.

For further information circle No. 944 on literature request card, page 48-D.

MINIMIZE BURN-OUT...
PSC's All-Sheet Construction Adds to Furnace Tube Life
Experience of users shows much lower frequency of burn-out, with tube life extended up to 100%. In PSC tubes, precision-welded bends are of same metal and thickness as the legs. The continuously smooth walls result in uniform flow of gas, and reduce the carbon build-up and bend burn-out, which commonly result from the rough interiors of cast alloy bends. Lighter than cast by 33 to 50%, PSC radiant tubes cost less initially. Any size, shape or alloy.
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Biggest turbine scroll cases built 50% lighter with USS "T-1" Steel

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Four of these cases, the largest in the United States, have been fabricated from USS "T-1" Constructional Alloy Steel by the Chicago Bridge & Iron Company. They will harness the flow of the Clark Fork River in the Noxon Rapids Dam, a project of the Washington Water Power Authority.

USS "T-1" Steel was used for the cases because of its high minimum yield strength of 90,000 psi. (100,000 psi for non-code applications.) This permitted a reduction in plate thickness of about 50% with sizeable savings in welding costs, freight and foundation costs. Welding on the job was readily done and there was no need for stress relieving.

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USS "T-1" Steel is an extra strong, tough, weldable steel with high resistance to impact abrasion and corrosion. Both mobile and stationary equipment can be built bigger, stronger and more durable. Payloads can be increased and operating costs drastically reduced. Your products are worth more because they do more and save more when built of USS "T-1" Steel. For information about USS "T-1" Steel, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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United States Steel Supply — Steel Service Centers
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USS

Down go back-up roll costs with

USS Quality Forged Sleeves

PICTURED ABOVE is James S. Rennick, a metallurgist with twenty years' experience in the Forgings Division of U. S. Steel. Jim specifies composition, heat treatment, and other processing procedures essential to the production of assemblies as shown in the main picture—a back-up roll that will be used in the cold reduction tin mill at U. S. Steel's Gary, Indiana plant.

This job points up a curious situation: U. S. Steel is one of the country's leading manufacturers of rolls, and also one of the biggest *users* of rolls . . . a double reason to perfect their performance and reduce their cost . . . just as we did here.

We had to replace a worn, cast steel back-up roll. Rather than replace the entire roll, we machined the face of the roll and shrunk on a *forged* steel sleeve. For back-up rolls like this one, 42" O.D. and larger, this method of sleeving is much less expensive than buying a complete new roll. One arbor can be used for several forged sleeves. A forged sleeve has a hard, wear-resistant surface and is highly resistant to spalling.

Also, the sleeve is purposely produced with a softer bore to develop a desirable stress pattern, and to provide maximum gripping between the arbor and sleeve after assembly.

There is a good possibility that we can help reduce *your* roll costs. Write or call the United States Steel Office nearest you, or United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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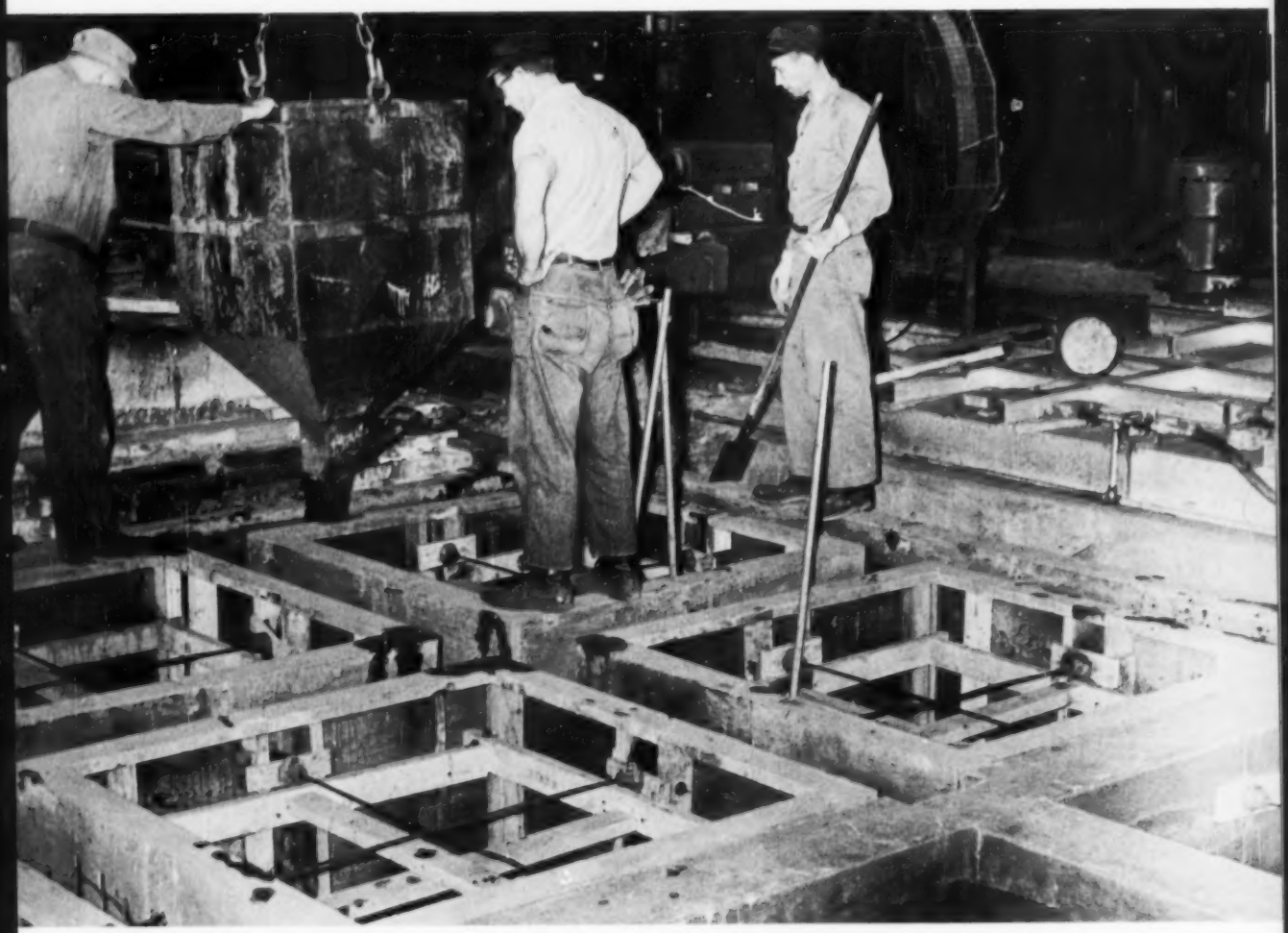
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Export Company

United States Steel

Slow-cooling pits cost less to build with refractory concrete made with Atlas Lumnite Cement



Vanadium-Alloys Steel Company, Latrobe, Pennsylvania, saved time and money by constructing slow-cooling pits with refractory concrete made with Lumnite calcium-aluminate cement. Using plant labor, 24 refractory concrete pits were formed in record time. With re-usable wood forms, material costs were greatly reduced. And procedures and equipment typical of any standard concrete construction work helped speed the job. The result was a smooth, jointless concrete pit that will resist thermal shock and wear and tear of charging and unloading hot alloy ingots.

For added convenience and economy in refractory concrete construction, castables made with Lumnite cement are available. These are packaged mixtures, ready for use. Simply add water, mix and place. Made by leading manufacturers of refractories. For more information, write Universal Atlas, 100 Park Avenue, New York 17, N. Y.

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L-180

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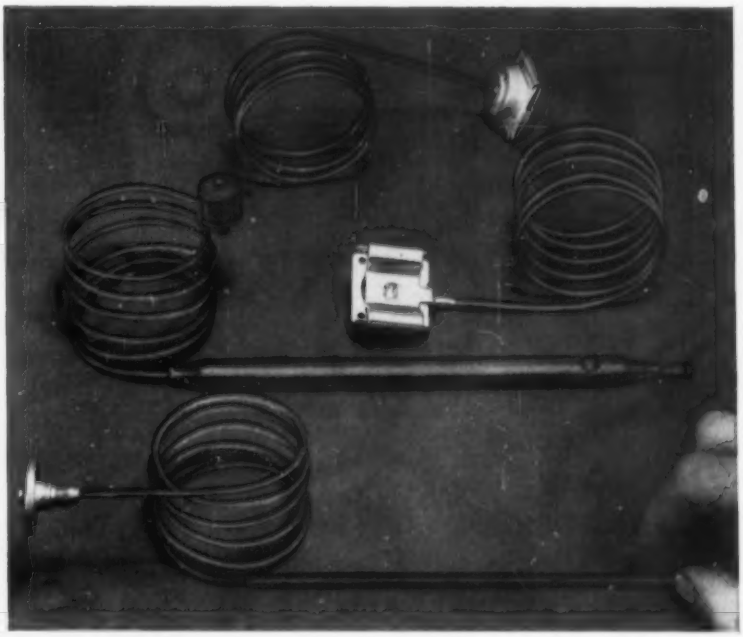
10 TO 15 NEW JOBS a week, each a different application, require a continuous program of evaluating the properties of metals and fabricating costs at Robertshaw-Bridgeport.



In making bellows (left) and temperature sensors (above) to meet ever-changing needs of control, appliance, and industrial equipment manufacturers, Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., Milford, Conn., averages 10 to 15 new problems a week. Specifications vary widely in dimensions and physical characteristics. Dependable performance over long periods of uninterrupted service is vital—yet costs must be rigidly controlled.

So for quality with maximum economy in fabrication, materials must be matched precisely to the needs of each job. And in this, Robertshaw-Bridgeport looks to its suppliers for creative technical services. For many years, The American Brass Company specialists have been helping to select the correct alloys in phosphor bronze or brass and to meet fabrication problems in the making of bellows—to apply economically precision-made capillary tubing and other small-diameter copper tube in sensor assemblies. Through such services, The American Brass Company is constantly helping metal fabricators across the nation control quality while keeping costs down.

ARE you caught between cost reduction and quality control? Find out if you are buying metal properties you don't need. An Anaconda specialist may be able to suggest a lower cost alloy that fits the requirements of your job more closely. Or he may find that an adjustment of temper or a change in your fabrication methods can cut your costs. The services of Anaconda specialists are available through your American Brass representative. Call him in today, or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

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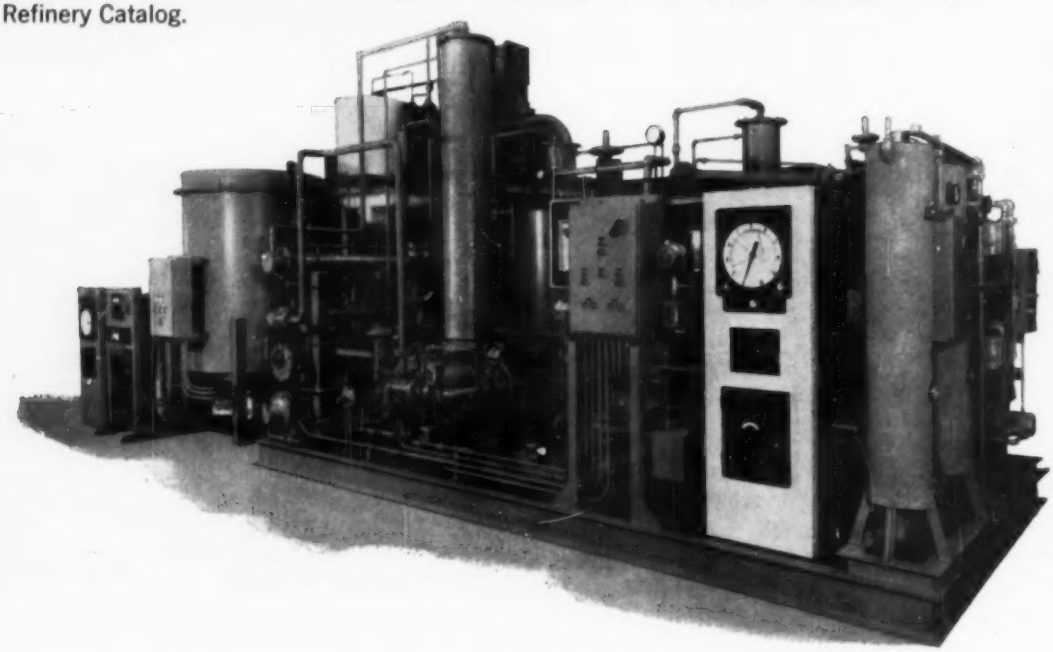

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Tool Steel Topics

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BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

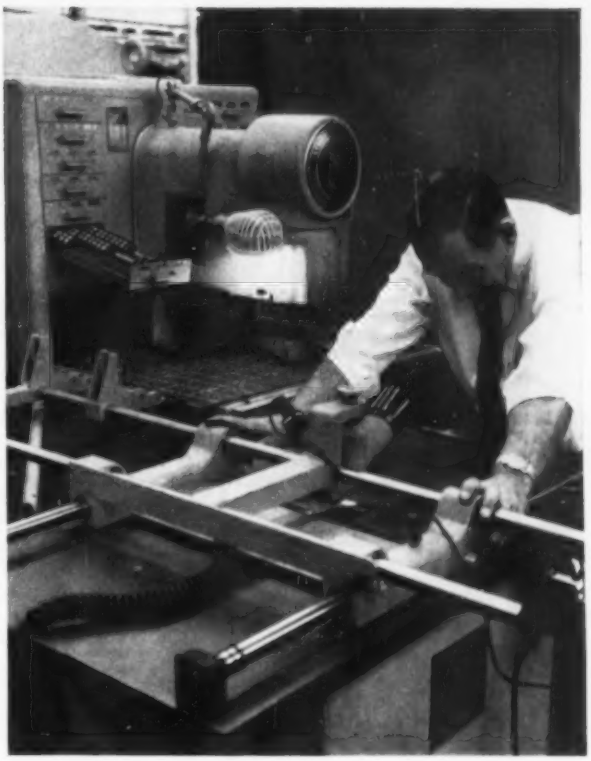
It's so easy to punch hole patterns fast with BTR

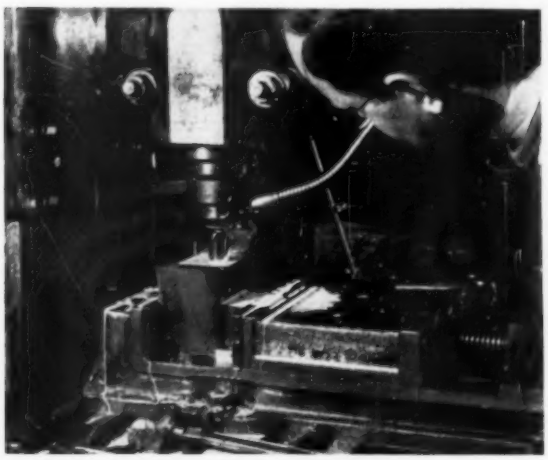
A punch made from BTR tool steel is the key element in this punching mechanism. It speeds the accurate reproduction of hole patterns, by remote control from a template, in sheets of steel, brass, aluminum, or plastic.

The BTR punch has proved both reliable and economical. This is the report from Wales-Strippit Inc., Akron, N. Y., a unit of Houdaille Industries, producers of the equipment. The Bethlehem tool steel is supplied by Leed Steel Co., Buffalo, one of our local tool steel distributors.

BTR is Bethlehem's general-purpose manganese-chromium-tungsten grade of oil-hardening tool steel. It's safe hardening, easy to machine. Combining abrasion-resistance and toughness, it's ideal for a wide range of tool and die uses.

Put BTR to work in your shop. A trial order can be delivered quickly by your Bethlehem tool steel distributor who carries BTR in stock in a wide size range.





New Free-Machining Tool Steel

Bethlehem Air-4 is an air-hardening tool steel which can save you time and money in scores of applications. It is a free-machining grade, and hardens at about 1550F. It combines excellent wear-resistance with a high degree of toughness. Ask your distributor for full data on Bethlehem Air-4.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Decarburized surfaces are the cause of premature tool failures

The great majority of toolmakers know that decarburized metal must be removed completely from the working surfaces of tools. It is not so widely known that it is often best to remove this skin from other portions of the tool.

This precaution is especially necessary on tools which are subject to repeated impacts. For example, a pneumatic chisel which has a forged shank often breaks because of a fatigue failure. As a rule there is a stress concentration in the shank, due to the change in section. When this tool surface is also decarburized, rapid failure in service can occur.

The outer layers of a decarburized tool haven't the strength of the effectively hardened tool steel base. Therefore only one procedure can be considered safe. It is to grind off the "decarb" on *all* tool surfaces.

Hayes Type LAC-50M Conveyor Furnace for alloying transistors and diodes as well as other brazing work provides 3-zone heat control to obtain exact temperature curve profile required for each operation. Continuous and automatic, LAC-50M puts "push-button" brazing on a fast paying basis.

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Hayes BAC-200 series furnace for high-production stainless steel brazing.

Pioneer of controlled atmosphere heat treating, C.I. Hayes developed the *first* electric furnace for stainless steel brazing. Today, Hayes offers one of the most extensive lines of heat treating equipment for brazing: including conveyor, straight-through, vacuum, forced-convection furnaces . . . plus all types of atmosphere generators.

Hayes "know-how" also offers you *customized techniques* for brazing. Hayes engineers determine the proper selection of alloys, correct placing and fixturing of work, choice of atmosphere, and proper time-temperature cycles for the full range of metal bonding applications . . . from aluminum alloys (900°F range) to such precious metals as platinum (3400°F range). Hayes "show-how" then proves the technique, using actual production-line equipment in our laboratory.

The Hayes *Results Guaranteed* answer to your brazing problem comes to you as a *complete package*. Our engineers provide free start-up service to duplicate laboratory results in your plant. Your staff is shown how to make brazing operations most economical, and how to maintain equipment for maximum life . . . to help you improve your product, increase production and reduce unit costs.

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APPLICATION and EQUIPMENT new literature

946. Abrasive Cleaning
Folder on Mallcabrasive for airless blast cleaning equipment gives advantages, grades, equipment it can be used with and parts that can be cleaned. *Globe Steel Abrasive.*

947. Abrasive Cleaning
Catalog 57-WX on brush types, sizes, speeds, filaments. Aids to power brush selection. *Pittsburgh Plate Glass*

948. Abrasives
Selection chart for basic coated abrasives for metalworking operations. *Abrasives Div., Carborundum Co.*

949. Alloy Castings
Data folders on two types of alloy steel castings. Composition, properties, hardenability bands, uses. *Unitcast*

950. Alloy Steel
32-page book on abrasion resisting steel. Properties, fabricating characteristics, uses. *U. S. Steel*

951. Aluminum Cleaner
Data sheet on acid solvent cleaner for aluminum and its alloys. *Northwest Chemical*

952. Aluminum Die Castings
Bulletin on design and manufacture of aluminum die castings. *Hoover Co.*

953. Aluminum Extrusions
Folder lists alloys used, finishes, trade phraseology. *General Extrusions*

954. Aluminum Extrusions
Catalog of extrusion dies in stock. *Jarl Extrusions*

955. Ammonia
69-page data book on anhydrous ammonia and ammonia liquor. Chemical and physical properties, specifications, analytical procedures, bibliography. *Nitrogen Div.*

956. Annealing Furnaces
8-page illustrated booklet on continuous annealing furnaces. Schematic diagrams, photographs, and actual production data. *Drever Co.*

957. Atmosphere Control
Bulletin 5702 on atmosphere control method and how it operates in heat treatment of steel and nonferrous metals. *C. I. Hayes*

958. Atmosphere Furnace
4-page bulletin on automatic continuous heat treating furnace. Operational advantages, principle of operation, capacity, construction. *American Gas Furnace*

959. Atmosphere Furnaces
4-page bulletin on furnaces for hardening high carbon and high speed tool steels. Diagrams, specifications and performance data. *Lindberg Engineering*

960. Atmosphere Generators
New 4-page bulletin I-457 includes flow charts and cost analyses of inert gas system. *Gas Atmospheres*

961. Atmospheres
8-page bulletin on heat treating. Data sheets on processes and processing equipment. Also covers annealing, brazing and hardening. *Ferrotherm*

962. Atmospheres
Metal Minutes, Vol. 18, No. 1, describes atmosphere equipment and gives advantages of each generator or dissociator. *Sunbeam Equipment Corp.*

963. Austempering
Tips and Trends, Vol. 12, No. 1, discusses mechanized austempering of harrow disks. Heat treat line diagramed. *Ajax Electric*

964. Barrel Finishing
29-page book on such barrel finishing processes as deburring, coloring, burnishing, descaling, cleaning, rust prevention. Case histories. *Magnuson Products Corp.*

965. Barrel Finishing
New 8-page booklet on barrel finishing compounds for deburring, burnishing, and descaling. Uses. Proper barrel technique. *Oakite*

966. Beryllium
24-page booklet on properties, corrosion resistance, machinability, formability and joining of beryllium. Toxicity of beryllium and beryllium as an alloying material. *Brush Beryllium Co.*

967. Black Oxide Coatings
8-page booklet on black oxide coatings for steel, stainless steel and copper alloys. *Du-Lite Chemical Corp.*

968. Blast Cleaning
New 12-page booklet on blast cleaning equipment describes vacuum-cast heat treated steel abrasive. *Pangborn*

969. Brazing
52-page publication GEA-3193C on how and where to use electric furnace brazing. Limiting creep of brazing metal, selecting the brazing metal, strength of furnace-brazed parts, how to braze cast iron, causes of distortion. *General Electric*

970. Brazing
8-page bulletin S-1050 on production brazing and soldering with automatic machines. Construction of custom models. *Selas*

971. Brazing Carbide
Bulletin 542 on brazing hard carbide with Silvaloy plymetal. Joint requirements, brazing procedures, thermal stress in brazing carbide tips. *American Platinum Works*

972. Brazing Cast Iron
Brazing News No. 80 tells how to braze cast iron. Design changes possible when brazing is used. How to braze cast iron to brass. *Handy & Harman*

973. Carbides
New 22-page catalog on tungsten, titanium, columbium and tantalum carbides. Physical and mechanical properties. Applications. *Kennametal*

974. Carbonitriding
28-page booklet on nature of process, furnaces, atmospheres, parts carbonitrided and properties. *Armour Ammonia*

975. Castings
Brochure on plaster mold castings of brass, bronze, aluminum, beryllium copper. *Ohio Precision Castings, Inc.*

976. Chromate Finishing
File on chromate conversion coatings for prevention of corrosion and paint-base treatment of nonferrous metals. *Allied Research Products*

977. Chromium Plating
Bulletin CFC-1 on advantages of crack-free chromium plating process. *Metal & Thermit*

945. Abrasive Wear

What abrasive wear is, its economic significance and molybdenum-containing alloys to combat it are described in this new 36-page booklet. Chromium-molybdenum steels, 3-2-1 alloy, 15-3 alloy and 12-2 alloy are rated as to their resistance to

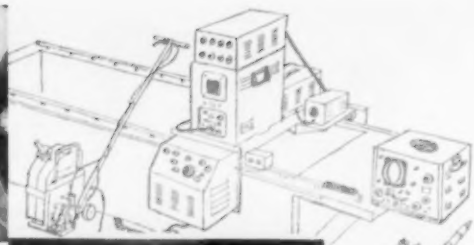
abrasive wear in such applications as ore crushers, scrapers, grinding mills, discharge grates, liners, pug-mill paddles. The properties, composition, heat treatment, machining, and welding and cutting of these four alloys are also given. *Climax Molybdenum Co.*

978. Cleaning
Bulletin on Ty-Bonds for cleaning and coating metals. *Coules Chemical*

979. Coatings
20-page bulletin on chemical conversion coatings. How and where each is used. Blackening process. *E. F. Houghton*

980. Coatings
4-page catalog on heat-proof protective coatings. Basic types, applications, methods of applying and temperature ranges. *Markal Co.*

981. Cold Rolling
Description of advantages of cold roll-



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ing of ship propeller shafting. How it is done. *Erie Forge & Steel*

982. Compressors
12-page data book 107-D gives engineering information on characteristics of turbo-compressors. 18 types of application described. *Spencer Turbine*

983. Controller
6-page Bulletin No. 3885 on Pyrotroller, an indicating-controlling pyrometer. Design, specification, applications. *Illinois Testing Lab.*

984. Copper Alloys
16-page publication E-5 on physical properties and applications of high-strength, corrosion-resistant copper alloys. *American Brass Co.*

985. Crucibles
Bulletin C1-55 on crucibles for service to 2900° F. *McDanel Refractory Porcelain*

986. Cutting Oils
Folder describing nine types of cutting oils for varied applications. *Gulf Oil*

987. Degreaser
Folder on automatic degreaser. Cleaning and solvent cycles described. Features of equipment. *Detrex*

988. Degreasing
Booklet on vapor degreasing. Design, installation, operation and maintenance of equipment. *Circo Equipment*

989. Degreasing
Data Sheet No. 787-A on degreasing with trichlorethylene. Description, uses, specifications, precautionary information. *Hooker Chemical Corp.*

990. Descaling
16-page Bulletin 608 on how Rotoblast descaling machine operates, outstanding features, examples of its use. *Pangborn*

991. Dew Point Control
Bulletin No. 21-C on instrument which indicates, records and controls dew point automatically. *Ipsen*

992. Die Castings
New 64-page book on uses of zinc die castings. Composition and properties of Zamak alloys. *New Jersey Zinc Co.*

993. Die Steel
Folder and stock list on Olympic FM air hardening, high carbon-high chromium die steel with sulphide additives for improved machinability. *Latrobe Steel Co.*

994. Disintegrators
Catalog B-1 on disintegrator which will remove embedded broken tools. Specifications. *Jiffy Disintegrator*

995. Dryers
New 52-page Bulletin D-100 on dryers for air, gas and liquids for low dew points. *C. M. Kemp Mfg. Co.*

996. Dust Collectors
12-page bulletin on dust and mist collectors tells how they work and advantage. Specifications of various models. *Hammond Machinery Builders*

997. Electric Furnaces
Bulletin on electric heat treating furnaces gives summary of progress in furnace developments. *Holcroft*

998. Electric Furnaces
Bulletin on furnaces for all types of heat treating and hardening, both standard and custom designed. *Pacific Scientific*

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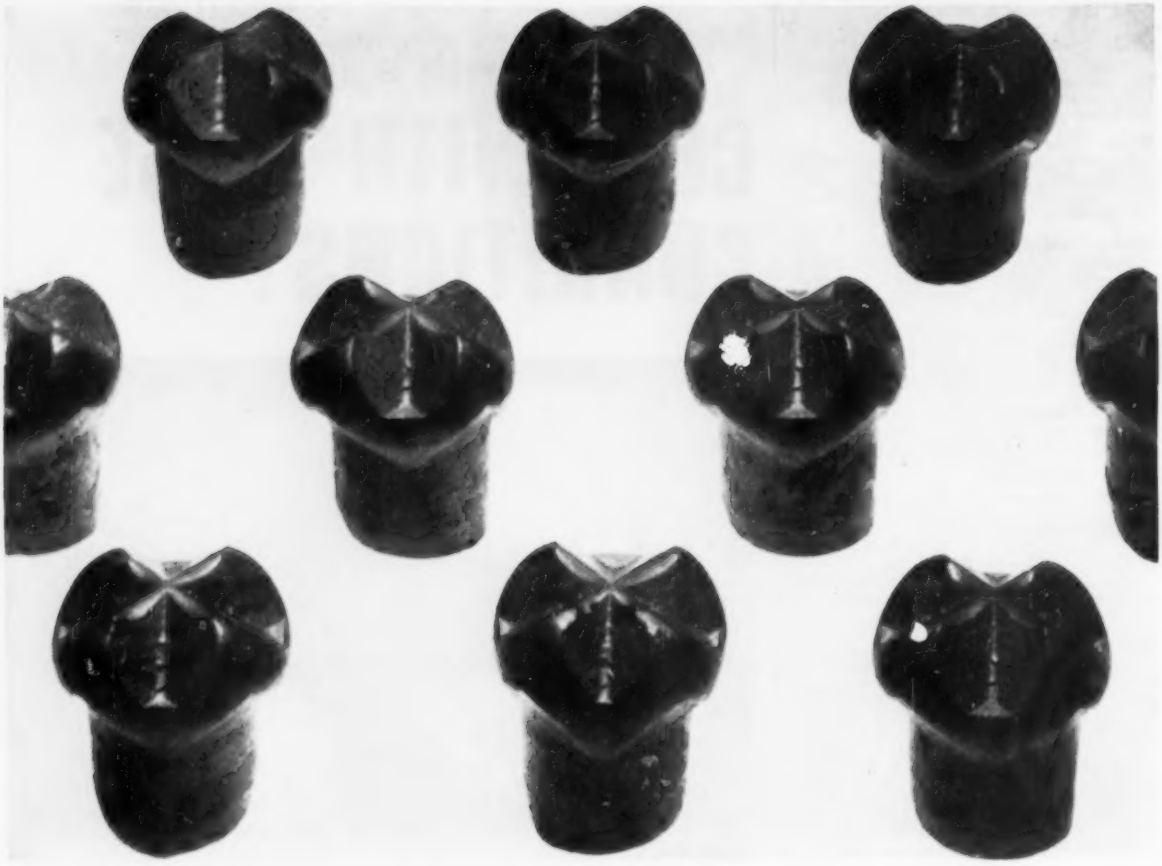

It actually costs less to get uniform forged quality like this

THIS is an actual unretouched photo of rock bit forgings made from Timken® forging bars steel. It costs less to get this uniform forged quality when the steel is uniform. And Timken steel doesn't vary in structure, chemistry or dimension from heat to heat, bar to bar, order to order. You don't have to interrupt to make costly adjustments when you forge with Timken steel.

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12-page article in Metal Digest, V. 1, No. 2, covers the theory and practice of electrolytic etching of metallographic specimens. *Buehler, Ltd.*

1001. Electrolytic Machining
New Bulletin No. 130 on resharpening milling cutters by electrolytic removal. How to install equipment. *Anocut Engineering Co.*

1002. Electronic Heaters
Bulletin GEA-6388 on electronic induction heaters. Specifications, design and construction. *General Electric*

1003. Environment Chambers
New folder on temperature, humidity chambers. Models, specifications. *Harris Refrigeration Co.*

1004. Extrusion
Folder describes the hot extrusion process and gives its history. *Jones & Laughlin*

1005. Ferroalloys
Folder on ferromanganese-silicon gives its analysis and advantages. Calculations of cost savings. *Union Carbide Metals*

1006. Film Thickness Tester
Data sheets give ranges, principle of operation of nondestructive thickness tester. *Unit Process Assemblies*

1007. Flame Hardening
Bulletin tells how flame hardening improves rolls. Chart shows ranges and depth of hardness. *Detroit Flame Hardening*

1008. Flow Meters
New 22-page Bulletin F-1607 on flow meters. Uses and characteristics. Tables of flow calculations. *Bristol Co.*

1009. Flow Meters
Bulletin 203 on flow meters for gas used in heat treating. *Waukee Eng'g.*

1010. Forgings
Folder on facilities for production of flat-die forged products. Electronic equipment used. *Smith-Armstrong*

1011. Formed Plate
Bulletin on stainless steel flanged heads. 246 available dies listed. *G. O. Carlson*

1012. Formed Shapes
Catalog No. 1053 describing numerous formed shapes made from ferrous and nonferrous metals. *Roll Formed Products*

1013. Freezer
Data on chest for use down to −140° F. for production and testing. *Revco*

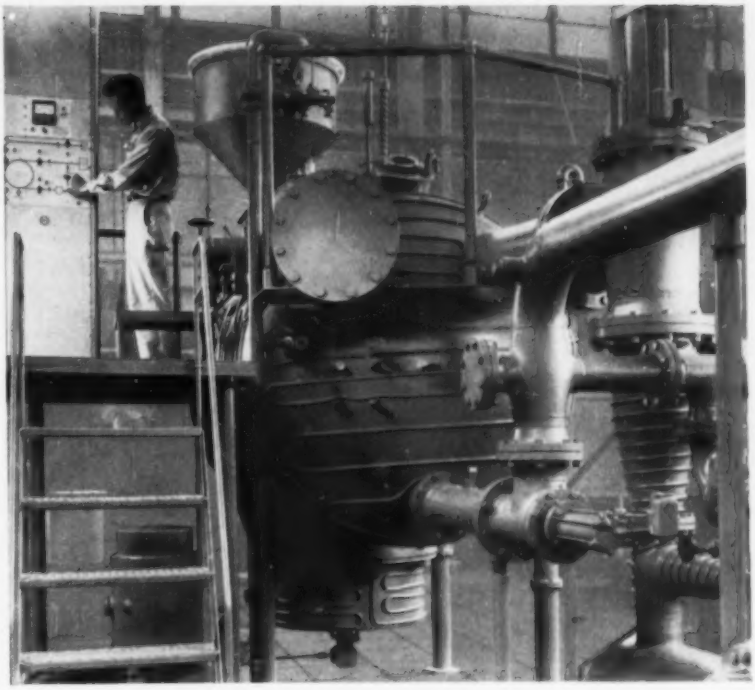
1014. Furnace Controls
Bulletin 658 on saturable reactor for regulation and control of electric ovens and furnaces. *Sorgel Electric Co.*

1015. Furnace Fixtures
16-page catalog on baskets, trays, fixtures and carburizing boxes for heat treating. 66 designs. *Stanwood*

1016. Furnaces
New 12-page Bulletin No. 653A, describing range of electric and fuel-fired heat treating furnaces and protective atmosphere generators. Includes batch furnaces and nonferrous metals melting furnaces. *Hevi-Duty*

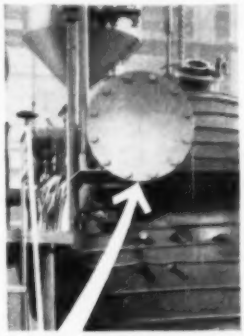
1017. Furnaces
12-page catalog on electric heat treating furnaces. Data on each of 57 models. Controls, instruments, elements and accessories. *Lucifer Furnaces, Inc.*

1018. Furnaces
New 26-page Bulletin S-1056 on steel heating equipment. Uses and applications. *Selas*



Get started in vacuum metallurgy this sensible pay-as-you-grow way

You may never need more than the basic 50-to-200 lb. capacity of the CEC vacuum induction furnace shown above. It's ample for medium-scale melting and casting. But if your needs change, as they well may in this rapidly expanding field, you can easily increase capacity to 300 lbs. Just open the flanged nozzle (arrow, left) and add another pumping system. Similarly, with the CEC laboratory and pilot plant model, you can start out with 5 lb. melts, then only change crucibles to accommodate 12, 17, 30, even production-rate 50-lb. melts. Same with the big CEC large-scale production model . . . it's expandable from 300 to 1000 lbs. The capacity is there, if you want it. You pay only for what you need, when you need it.



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1019. Furnaces
Folder describes complete setup for heat treatment of small tools, including draw furnace, quench tank and high temperature furnace. *Waltz Furnace*

1020. Furnaces, Heat Treating
12-page bulletin on conveyor furnace, radiant tube gas heated, oil or electrically heated. *Electric Furnace Co.*

1021. Gold Plating
Folder gives data on plating to obtain a hard bright gold finish. *Technic*

1022. Graphite
4-page catalog section S-5050 on impervious graphite and resin-base cements for corrosive service. 2-page table gives recommendations for commercial applications. *National Carbon*

1023. Graphite
Folder on graphite crucibles, funnels, and special preformed electrodes. High-purity powder. *United Carbon Products*

1024. Graphite Electrodes
New 6-page folder describing graphite electrodes for electric furnaces. Stock list of threaded graphite electrodes and their corresponding nipples. *Great Lakes Carbon*

1025. Guides
8-page booklet on web-guide equipment. Relays, regulators, power units. Applications. *North American Mfg. Co., Hydraulic Controls Div.*

1026. Hardness Tester
Bulletin F-1689-3 on Impressor portable hardness tester for aluminum, aluminum alloys and soft metals. *Barber-Colman*

1027. Hardness Tester
20-page book on hardness testing by Rockwell method. *Clark Instrument*

1028. Hardness Tester
Data on portable hardness tester with Rockwell and Brinell scales. *Mechanical Devices*

1029. Hardness Tester
Data on impact Brinell hardness tester. *Newage Industries*

1030. Hardness Tester
Catalog 505 on Frank hardness tester for Rockwell B and C, Brinell and Vickers hardness tests. *Opto-Metric Tools*

1031. Hardness Tester
Bulletin S-33 on vertical-scale and dial-indicating scleroscopes. How they are calibrated. *Shore Instrument*

1032. Hardness Tester
Bulletin TT-59 on tester for measuring standard Rockwell and superfine hardness. *Wilson Mechanical Instrument*

1033. Hardness Testers
4-page bulletin on hardness tester for regular and superficial Rockwell tests. Special features and accessories. *Torsion Balance*

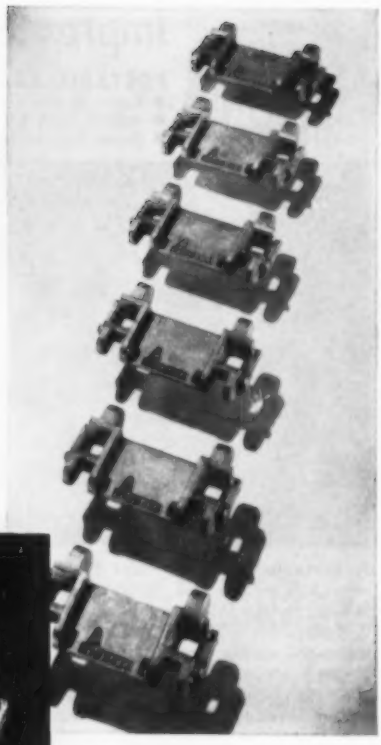
1034. Hardness Testing
Bulletin A-18 on Alpha Co. Brinell hardness testing machines. *Gries Industries*

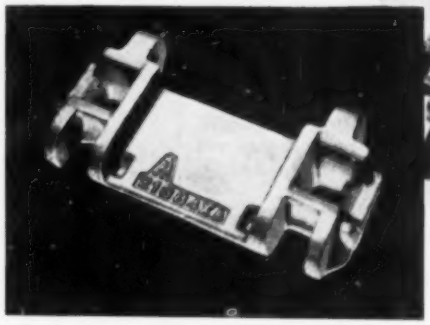
1035. Heat Treat Pots
Catalog on pressed steel pots for lead, salt, cyanide, oil tempering and metal melting. *Eclipse Industrial Combustion*

1036. Heat Treat Pots
6-page folder gives stock shapes and sizes. Tips on installation and use. *Electro-Alloys Div.*

1037. Heat Treating
8-page bulletin on heat treating. Data sheets on processes and processing equipment. Also covers annealing, brazing and hardening. *Ferrotherm*

A QUARTER MILLION "STEPS" IN THE RIGHT DIRECTION..





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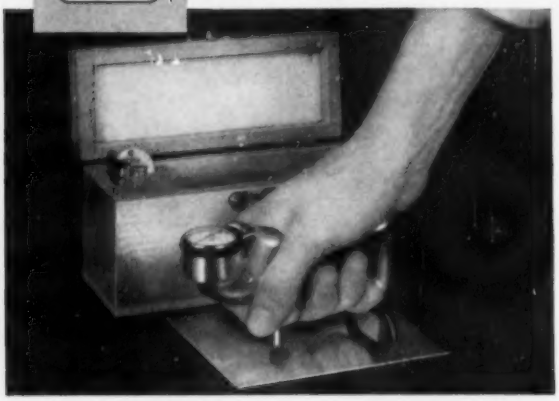

A portable hardness tester for brass, copper, aluminum, other soft metals, and plastics, the Barber-Colman Impressor is designed for fabricated parts and raw stock testing. Operating experience is not essential. The reading is instantly indicated on the convenient dial. No waiting, preloading, or separate measurements. Barber-Colman engineers will gladly recommend the most suitable model for your application. Write today for complete details.

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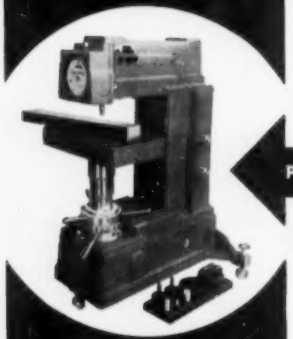

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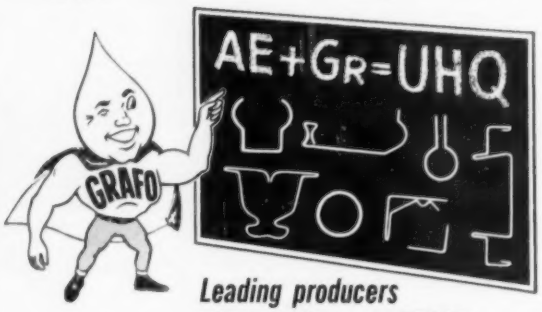

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1038. Heat Treating
Monthly bulletin on used heat treating and plating equipment available for immediate delivery. *Metal Treating Equipment Exchange*

1039. Heat Treating
Loose-leaf data sheets on heat treating oils, salts, carburizing compounds. *Park Chemical*

1040. Heat Treating
Heat Treat Review, Vol. 9, No. 3, on a flexible setup for heat treating a variety of gears. *Surface Combustion*

1041. Heat Treating Belts
12-page catalog of conveyor belts and data for their design, application and selection. *Ashworth Bros.*

1042. Heat Treating Fixtures
4-page folder on retorts, baskets, trays, carburizing boxes, fans for heat treating. *Aluminum & Architectural Metals Co.*

1043. Heat Treating Fixtures
24-page catalog on heat and corrosion-resistant equipment for heat treating and chemical processing. 30 classifications of equipment. *Pressed Steel*

1044. Heat Treating Fixtures
32-page Catalog G-10A lists process equipment, heavy welded fabrications, muffles, trays, fixtures for furnaces, heat treating equipment, pickling equipment. *Rolock*

1045. Heat Treating Fixtures
16-page Catalog M-7 on heat treating baskets and corrosion-resistant-alloy fabrications. *Wiretex Mfg. Co.*

1046. Heating
Bulletin on Heat-O-Coil resistance wire for preheating and stress relieving. *Arcos Corp.*

1047. Heating Elements
12-page bulletin gives typical applications of silicon carbide heating elements. Hints on handling, unpacking, storage, installation, replacement. *Globar Div., Carborundum*

1048. High-Temperature Alloy
14-page bulletin on Udimet 500 gives composition, heat treatment, machinability, hot working characteristics and properties. *Utica Metals Div.*

1049. High-Temperature Alloy
Booklet "Keeping Costs Down When Temperatures Go Up." *International Nickel*

1050. High-Temperature Steels
87-page book on factors affecting high-temperature properties. 45 pages of data on tensile, creep and rupture properties of 21 high-temperature steels. *U. S. Steel*

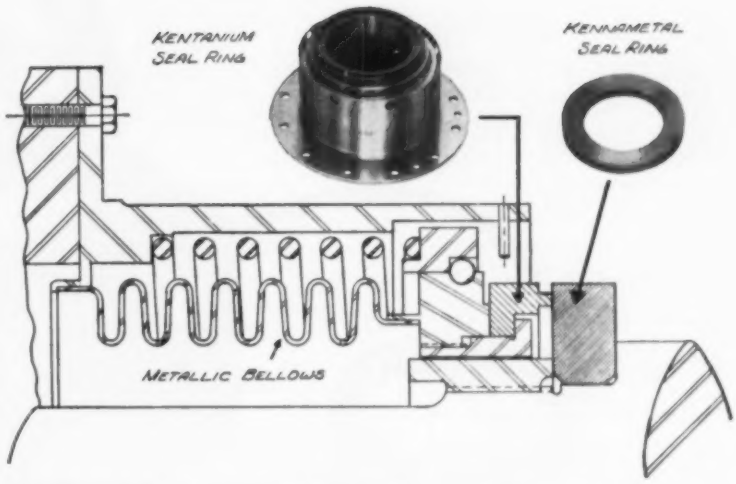
1051. High-Tensile Steel
12-page bulletin on properties and composition of N-A-X high-tensile steel. Examples of resistance to impact, fatigue, abrasion and corrosion. *Great Lakes Steel*

1052. Identifying Stainless
Cardboard chart outlining systematic method for rapid identification of unknown or mixed stocks of stainless steels. *Carpenter Steel*

1053. Induction Brazing
Folder tells how tips of carbide may be brazed on tool shanks. *Ohio Crankshaft*

1054. Induction Heater
8-page bulletin on 60-cycle induction heater for aluminum, copper, brass and steel. Installations, aluminum billet heater selection chart. *Magnethermic*

1055. Induction Heating
Folder 15C8053C gives advantages of induction heating and specifications and dimensions of induction heater. *Allis-Chalmers*



KENNAMETAL* Rotary Seal Rings provide substantially zero leakage at mile-a-minute rubbing speeds

At rubbing speeds of 4200 to 5400 ft./min., the hydraulically balanced seal shown above achieves substantially zero gas leakage. Excellent wear characteristics of the Kennametal and Kentanium* Seal Rings featured in this design make possible unlubricated dry rubbing at peak speeds.

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For more information, just outline your problem and send it to KENNAMETAL INC., Latrobe, Pa.

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The M-S-A® Portable Oxygen Indicator puts the finger on oxygen deficiency and hazardous oxygen leakage. In purging gas transmission lines or process systems of air, this precision instrument can be used to determine rate of progress.

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The versatility of such an instrument could add a big boost to the efficiency of your operation. Another consideration is the extra margin of safety it provides for work crews. Ask the MSA Representative for a demonstration, and write MSA for a descriptive bulletin.

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1056. Inspection
16-page catalog on illuminated Borescopes for industrial inspection of deep recessed areas. *National Electric Instrument Div.*

1057. Inspection
Data on ultrasonic inspection and thickness measurement service in field or laboratory. *Sperry Products*

1058. Investment Casting
7-page bulletin on economics of investment cast vacuum alloys tells how it is done, how much it costs. *Cannon-Muskegon, Inc.*

1059. Lab Test Dies
Complete information on multi-motion laboratory test specimen dies. *Haller*

1060. Laboratory Equipment
12-page catalog on high-frequency induction combustion units and accessories for carbon, sulphur and hydrogen analysis. *Lindberg Engineering*

1061. Laboratory Equipment
New loose-leaf catalog covering line of spectrographic and analytical equipment. 12 product bulletins give construction, features and specifications of different pieces of equipment. *National Spectrographic Lab.*

1062. Laboratory Equipment
Bulletin on cutting test specimens describes methods for different types of metals. Price list. *Sieburg Industries*

1063. Laboratory Furnace
Data on nonmetallic resistor furnaces for research, testing or small-scale production. *Harrop Electric Furnace*

1064. Leaded Steel
New 40-page data book on leaded steel forgings includes test results and case histories. 10 pages of tabular data and 13 of charts. *Alco Products, Inc.*

1065. Leaded Steel
8-page bulletin gives chemical composition, mechanical properties and case studies showing machining production rates of Ledloy, lead-bearing steel. *Ryerson*

1066. Leaded Steels
16-page booklet on basic characteristics, mechanical properties and workability of leaded steels. Case histories. *Copperweld Steel Co.*

1067. Lubricant
8-page booklet, "Biggest Ounce of Protection," tells of lubrication with colloidal graphite products. *Grafo Colloids*

1068. Lubricants
Application data about Prodag, Oildag, Emralon 310 and Emralon 320 are presented in Acheson 'Dag' Disperser. *Acheson Colloids*

1069. Lubricants
Bulletin 581 on colloidal graphite dispersions for industry. 17 uses listed. Tables on concentrated and ready-to-use solutions. *Graphite Products Corp.*

1070. Lubricants
New booklet giving information on company's complete line of industrial products. *Sun Oil Co.*

1071. Lubrication
26-page manual on lubrication of miniature instrument bearings. Various types and brands of oils and greases available to bearing designers and users. *Miniature Precision Bearings*

1072. Magnesium
53-page book on wrought forms of magnesium. Includes 44 tables. *White Metal Rolling & Stamping Corp.*

1073. Malleable Iron
New Data Unit No. 102 on importance of tensile strength, yield strength, fatigue strength and other strength factors, especially as applied to malleable irons. *Malleable Castings Council*

1074. Manganese
9-page article on electromanganese. Manufacturing procedures, product characteristics, uses. In Foote Prints, V. 28, No. 2. *Foote Mineral Co.*

1075. Marking
Data on Paintstik markers for identification of heat treated parts. *Markal Co.*

1076. Marking Machines
Bulletins 146-C25 and 146-C26 on complete line of marking machines, from stationary models to portable units. For polished surfaces, precision finished parts, glass, ceramics. *Jas. H. Matthews*

1077. Metal Cutting
New 56-page Catalog No. 32 gives prices and describes complete line of rotary files, burs, metalworking saws and other products. *Martindale Electric*

1078. Microhardness Tester
Bulletin describes the Kentron microhardness tester. *Torsion Balance*

1079. Microscopes
8-page booklet No. 5 on research microscopes, stages, illuminators and other accessories. *American Optical*

1080. Microscopes
40-page catalog on metallographs, metallurgical, toolmakers, stereoscopic, polarizing, phase and other microscopes. *Unitron Instrument Div., United Scientific*

1081. Nickel Alloy
New 12-page booklet on Hastelloy F gives physical, chemical, and mechanical properties, high-temperature strength and corrosion rate. *Haynes Stellite Co.*

1082. Nickel Alloys
38-page catalog on Monel, Inconel, nickel and nickel clad copper. Includes properties, applications and technical data. *Riverside-Alloy Metal*

1083. Nickel Tubing
New 20-page catalog gives properties and compositions of 13 analyses of nickel and nickel alloy tubing. Selection guide. *Superior Tube*

1084. Nondestructive Testing
8-page bulletin on equipment for nondestructive testing of bars, rods, tubing. *Magnetic Analysis*

1085. Nonferrous Alloys
New alloy chart showing comparative specifications, chemical analyses and the minimum physical properties of centrifugally cast nonferrous alloys. *Centrifugally Cast Products Div., Shenango Furnace*

1086. Nonferrous Forgings
34-page booklet on brass, bronze and aluminum forgings. How they are made, composition of alloys, tolerances. *Mueller Brass*

1087. Nonferrous Wire
Folder gives wire gage and footage chart and data on beryllium copper, phosphor bronze, nickel, silver, brass and aluminum wire. *Little Falls Alloys*

1088. Oil Quenching
8-page brochure tells in detail how carbon steel often can replace alloy steel when additive is used in the quenching oil. *Aldridge Industrial Oils*

1089. Oil Quenching
Catalog FB-1052-A on self-contained oil cooling equipment. Selection tables for volume of oil required and oil recirculation rates. *Bell & Gossett*

1090. Ovens
14-page Bulletin No. 53-CM on various types of core and mold ovens. Construc-

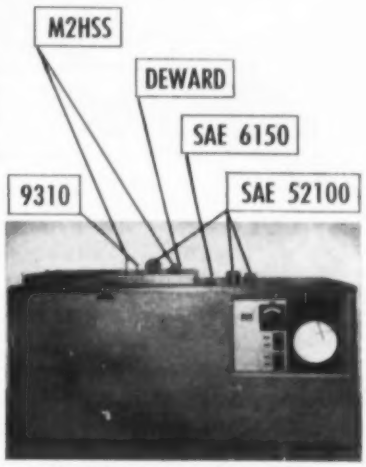
(*Continued on page 48A*)

HARRIS CHILLING EFFECTS CRITICAL MARTENSITIC STRUCTURE FOR NEW YORK AIR BRAKE PARTS

For four years the Watertown Division of The New York Air Brake Company has relied on their Harris Production Chilling Machine for dimensional stability in critical components.

Tool steels are used, as shown in the illustration. According to H. E. Crouse, Heat Treat Foreman of the Watertown Division, "The stability required in these parts demands as near 100% transformation as possible from austenite to martensite. Our Harris Chilling Machine has achieved this requirement to our complete satisfaction."

Actually leading metallurgists agree that by repeated chilling to —120° and tempering 100% transformation can be obtained.



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(Continued from page 47)

tion, operating principle, advantages. *Carl-Mayer*

1091. Ovens
Bulletin 4-257 on gas, oil and electric ovens. Load-carrying-door, electric-drawer and walk-in type ovens. *Grieve-Hendry*

1092. Oxygen Analyzer
New Bulletin No. 0704-1 on continuous oxygen analyzer with automatic calibrator. Process applications. *Mine Safety Appliances*

1093. Phosphor Bronze
New 4-page brochure on effects of precision annealing on spring-temper phosphor bronze sheet and strip. *Waterbury Rolling Mills, Inc.*

1094. Pig Iron
New 28-page book gives a brief history of pig iron production, how it is made, how it is used. *Republic Steel*

1095. Plating
8-page brochure on test equipment for plating baths. Controls, anodes, cathodes, agitators, rectifiers. *R. O. Hull*

1096. Polishing
12-page bulletin on grinders, polishing and buffing lathes, dust collectors. 46 models described and illustrated. *Hammond Machinery Builders*

1097. Potentiometer
Bulletin F-7955-1 on multipoint potentiometer recorder. Specifications, ranges, models. *Wheelco*

1098. Powder Metallurgy
Technical literature on high-density sintered metal parts. *Supermet Div., Globe Industries*

1099. Powder Metallurgy
Folder on tooling for powder metallurgy discusses high speed steels, die steels. *Vanadium-Alloys Steel Co.*

1100. Powdered Iron
12-page Bulletin No. 2 on iron powders. Properties of Plast/Iron, Plast/Steel, Plast/Nickel, Plast/Manganese and Plast/Silicon. *Plastic Metals Div.*

1101. Precision Casting
8-page bulletin on investment castings of various ferrous and nonferrous alloys. *Engineered Precision Casting*

1102. Press
Bulletin No. 1200 on 50-ton multiple-motion powder metal press. Operating characteristics, physical specifications. *F. J. Stokes*

1103. Presses
12-page brochure on horizontal, multi-station, automatic redraw presses. Details on 12 machines; advantages of multiple-station deep drawing; attachments. *Waterbury Farrel Foundry & Machine*

1104. Pyrometer
Catalog 95 gives advantages, applications, operating procedure, accessories. *Pyrometer Instrument Co.*

1105. Pyrometer
New bulletin on Shawmeter, direct-reading two-color pyrometer. *Shaw Instrument Corp.*

1106. Radiography
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1107. Radiography
16-page booklet on materials and accessories for industrial radiography. Guide to selection of film. Recommended development techniques. *Eastman Kodak, X-Ray Div.*

1108. Refractories
Bulletin 1922 on two high-temperature Alundum castable refractories. Properties and how to use them. *Norton Co.*

1109. Refractory Cement
Bulletin discusses refractories and heat-resistant concrete. *Lumnite Div.*

1110. Research Microscopes
20-page bulletin on dynoptic research microscopes. Special features, stages, various models, accessories, replacement parts. *Bausch & Lomb*

1111. Residual Stresses
32-page pocket-size booklet on residual stresses in cold finished steel bars and their effect on manufactured parts. *La-Salle Steel*

1112. Resistance Material
16-page brochure on high-temperature electrical resistance heating material. Electrical, chemical and physical characteristics. *Kanthal*

1113. Resistance Welding
28-page bulletin gives principles of resistance welding, resistance welding formulas, data on how to calculate welding pressures, time in cycles, current. *Federal Machine & Welder Co.*

1114. Rolling Mills
Data on 2-high/4-high combination rolling mill for metallurgical production and research. *Loma Machine Mfg. Co.*

1115. Rust Inhibitors
Catalog of rust-preventive compounds contains sections on theory of corrosion, how to apply rust preventives, data on several types. *Rust-Lick, Inc.*

1116. Rust Preventive
Bulletin on wetting agent and emulsifier for use at a rust preventive and corrosion inhibitor. *Swift & Co.*

1117. Saws
Catalog C-55 describes 35 models of metal-cutting saws. *Armstrong-Blum*

1118. Shell Molding
Advantages of shell molding, alloys cast, typical parts. *Ampco Metal*

1119. Shell Molding
Report on lubricants for shell molding. Methods of shell sand coating. Properties of three lubricants. *Nopco Chemical*

1120. Shot
Complete catalog on abrasive shot and grit. SAE specifications. Cleaning and peening methods. *Abrasive Shot & Grit*

1121. Sigma Welding
48-page booklet gives instructions on sigma welding of commercially available metals. Current, gas flow, joint design and filler metal recommendations. *Linde Co.*

1122. Silicon Carbide
New 107-page bibliography on silicon carbide. *Carborundum Co.*

1123. Slitter
16-page booklet on rotary gang slitters. Sheet and coil slitting methods summarized. *Stanat Mfg.*

1124. Slitting
76-page handbook on multiple rotary slitting lines. Design, selection and operation of slitters. Specifications and capacity tables. *Yoder Co.*

1125. Smelting
New 16-page brochure on electric-furnace smelting and refining of iron ore. Plant layout. Power and electrode requirements. *Koppers Co.*

1126. Soldering Fluxes
4-page bulletin on line of nonacid self-cleaning fluxes. How they work. *Lake Chemical Co.*

1127. Spectrographic Sources
4-page bulletin 35A on spectrographic source unit gives data on three units available. *Baird Atomic*

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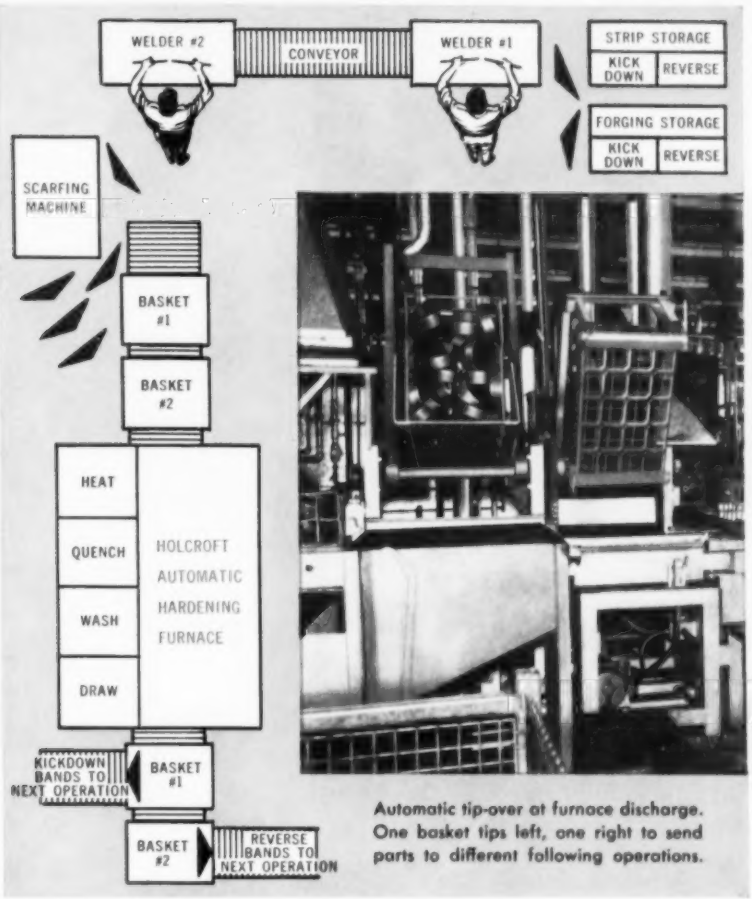

Automatic tip-over at furnace discharge. One basket tips left, one right to send parts to different following operations.

Fully automatic hardening furnace by HOLCROFT requires no operator...

Sorts hardened parts automatically

In this transmission parts line two welding operations, scarfing, hardening and two sorting operations are handled by just two welding operators . and a Holcroft automatic hardening furnace. The operator at the second welding station distributes his output into two baskets, one for kickdown bands and one for reverse bands. The Holcroft furnace collects both baskets, heat treats the parts and *automatically* sorts them onto two conveyors which carry them to separate additional operations, all without rehandling of the parts or attention of any kind.

Holcroft engineered and built eight of the furnaces in this modern automotive transmission plant and every one of them shows the same leadership in design concept and quality of construction. The result of this leadership is clear; top quality production, lowest possible operating costs, long, trouble-free life. These are the true measure of heat treating economy. Next time you have a heat treating problem, call on Holcroft engineers to show you how to get truly economical production.

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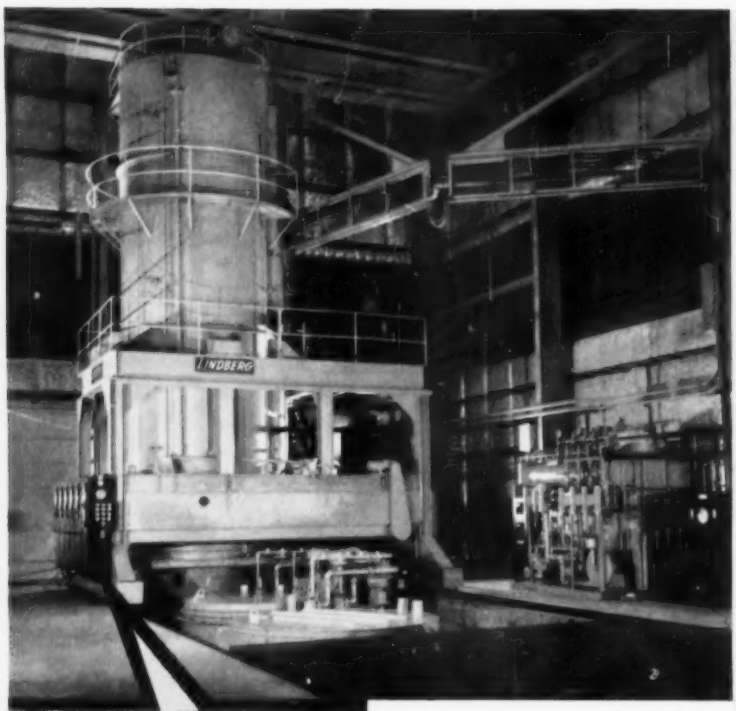
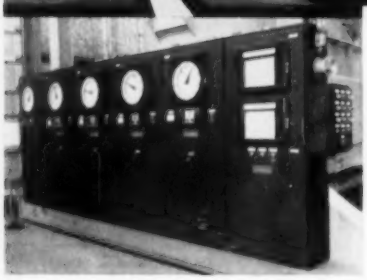
Wheelco Instrumentation Provides 5-Zone Control on Advanced-Design Furnace





New Lindberg Gantry-Type atmosphere hardening furnace handles missile and aircraft parts up to 24 ft long and 6 ft 8 in. diameter.

Complete Wheelco instrumentation includes five indicating controllers with 3-function control and two multipoint recorders.

Newest ideas in furnace design and instrumentation are skillfully blended on this atmosphere-controlled, bottom quench, gantry-type furnace designed to handle tomorrow's metals as well as meeting today's missile and aircraft needs. It was built by Lindberg Engineering Company for the Lindberg Steel Treating Company.

Furnace is heated electrically, has 5 control zones, and operates between 250°F and 2050°F. Temperatures are controlled to ultra-precise limits by five Wheelco Model 3000 indicator-controllers each provided with the MMC three-function control with magnetic modulation. These instruments, coupled with magnetic amplifiers and saturable core reactors, provide precise stepless control over the entire temperature range.

For more details on the new Wheelco Model 3000 instrument write today for Bulletin F-8939.

BARBER-COLMAN COMPANY

Dept. Q, 1518 Rock Street, Rockford, Illinois, U.S.A.

1128. Stainless Castings
Bulletin on advantages of corrosion-resistant castings. *Ohio Steel Foundry*

1129. Stainless Fastenings
20-page catalog of stainless steel cap screws, nuts, washers, machine screws, sheet metal screws, set screws, pipe fittings and specialties. *Star Stainless Screw*

1130. Stainless Steel
8-page catalog of stainless sheet and plates. Analyses, finishes, sizes. *Eastern Stainless Steel Corp.*

1131. Stainless Steel
Booklet on 430 stainless. Properties, fabrication. *Sharon Steel*

1132. Stainless Steels
10-page booklet contains charts, graphs, data on cold rolled mechanical properties, elevated temperature properties, physical properties and corrosion resistance of chromium-nickel manganese steels. *Allegheny Ludlum*

1133. Steel
Chart gives properties analyses specification designations and heat treatment of carbon, alloy and stainless steel castings. *Lebanon Steel Foundry*

1134. Sub-Zero Treatment
New 10-page bulletin on industrial chilling equipment for shrinking, testing and treating of metals. *Cincinnati Sub-Zero Products*

1135. Tempilstiks
"Basic Guide to Ferrous Metallurgy," a plastic laminated wall chart in color. *Claud S. Gordon*

1136. Tempilstiks
Folder 571 on Tempilstik, pellets and Tempilaq, temperature indicating devices. *Tempil® Corp.*

1137. Tensile Testing
15-page reprint on use of Instron tensile testing machine to observe resistance recovery. *Instron Engineering Corp.*

1138. Test Equipment
Catalog R-36A on complete line of testing equipment, including all industrial electronic and electrical equipment. *Weston Electrical Instrument*

1139. Testing
Brochure on facilities for metallurgical testing. Methods of analysis of high-temperature alloys. *Frank L. Crobaugh Co.*

1140. Testing
Literature on pickle pills for testing strength of pickling solutions. *Ferro Corp.*

1141. Testing Machines
32-page booklet on hydraulic universal testing machines describes machines, accessories and calibrating service. *Riehle*

1142. Testing Machines
Bulletin on Brinell hardness, ductility, compression, tensile, universal, transverse, hydrostatic proving instruments. *Steel City Testing Machines*

1143. Thickness Gage
Bulletin on noncontacting thickness gage. Range, sensitivity, speed of response. *Nuclear Systems, Budd Co.*

1144. Thickness Tester
Bulletin 400 on electronic testers for determining plating thickness. Applications of various models. *Kocour Co.*

1145. Tin
20-page bulletin on importance of tin to the American industry. Applications in aircraft, chemical, container, electrical, electronic equipment. *Malayan Tin Bureau*

1146. Titanium
36-page booklet on how titanium is made, the advantages of titanium, corrosion properties and specifications of the various alloys. *Harvey Aluminum*

1147. Titanium
8-page booklet on corrosion resistance of titanium. Table of ratings of titanium compared with stainless and aluminum in various mediums. *Mallory-Sharon Metals*

1148. Tool Steel
Color guide to estimate temperatures has heat colors on one side and temper colors on the other. *Bethlehem Steel*

1149. Tool Steel
New 16-page Bulletin No. M80 describes characteristics of precision ground tool steel and low carbon ground flat stock. *Brown & Sharpe*

1150. Tubing
New 24-page bulletin on integral finned tube. Specifications, sizes, applications, packaging. *Wolverine Tube Div.*

1151. Tukon Tester
12-page Bulletin DH-328 on Tukon micro and macrohardness testers. *Wilson Mechanical Instr.*

1152. Ultrasonic Cleaning
New 24-page Bulletin S-200 explains practical applications and basic principles of ultrasonic cleaning. Design of equipment. *Branson*

1153. Ultrasonic Cleaning
New bulletin gives tips on ultrasonic cleaning. *Circo Ultrasonic*

1154. Ultrasonic Inspection
Ultrasonic Inspection Newsletter No. 2, contains article on immersion inspection of wing spars for jet fighters. *Sperry Products, Inc.*

1155. Vacuum Dryers
New Bulletin No. 630 on vacuum shelf dryers. Sizes and specifications. *F. J. Stokes*

1156. Vacuum Furnace
New Bulletin 807 on laboratory vacuum furnace. Specifications, applications, accessories. *Kinney Mfg.*

1157. Vacuum Furnace
Folder on vacuum button furnace with multiple button hearth for high-purity melts. *Zak Machine Works*

1158. Vacuum Furnaces
Data on high-temperature high-vacuum retort furnaces. *General Vacuum Corp.*

1159. Vacuum Pumps
New 68-page Bulletin 6-1 on high vacuum vapor pumps. Describes technique and pumping systems. Tables, charts and graphs. *Rochester Div., CEC*

1160. Vanadium
New leaflet on high-purity vanadium lists physical and mechanical properties and ratings of its machinability, formability and weldability. *Vanadium Corp.*

1161. Welder
Specifications and construction details for 300, 400 and 500 amp. combination a.c. and d.c. welders. *Lincoln Electric Co.*

1162. Welding
New 32-page catalog of welding products and guide to welding practice. Stainless, low-alloy, nonferrous rods and electrodes for manual, automatic and semi-automatic welding. *Arcos Corp.*

1163. Welding Alloy Steel
44-page Data Book 4D covers all types of welding of nickel alloy steels. *International Nickel*

1164. Woven Wire
22-page catalog on woven wire gripper slings. Advantages, typical uses, technical data. *Cambridge Wire Cloth*

1165. Wrought Iron
New 16-page booklet, "The ABC's of Wrought Iron". What it is, how it is made, fabrication, corrosion resistance, applications. *A. M. Byers Co.*

1166. X-Ray Diffraction
4-page folder 7A-3690 on X-ray diffraction. What it is, Bragg's law, equipment, applications. *General Electric, X-Ray*

1167. Zinc Coating
8-page booklet on zinc-coated steel sheets. Fabrication, uses, advantages in heating, ventilating and air conditioning. *Weirton Steel.*

MAY, 1959

922	947	972	997	1022	1047	1072	1097	1122	1147
923	948	973	998	1023	1048	1073	1098	1123	1148
924	949	974	999	1024	1049	1074	1099	1124	1149
925	950	975	1000	1025	1050	1075	1100	1125	1150
926	951	976	1001	1026	1051	1076	1101	1126	1151
927	952	977	1002	1027	1052	1077	1102	1127	1152
928	953	978	1003	1028	1053	1078	1103	1128	1153
929	954	979	1004	1029	1054	1079	1104	1129	1154
930	955	980	1005	1030	1055	1080	1105	1130	1155
931	956	981	1006	1031	1056	1081	1106	1131	1156
932	957	982	1007	1032	1057	1082	1107	1132	1157
933	958	983	1008	1033	1058	1083	1108	1133	1158
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935	960	985	1010	1035	1060	1085	1110	1135	1160
936	961	986	1011	1036	1061	1086	1111	1136	1161
937	962	987	1012	1037	1062	1087	1112	1137	1162
938	963	988	1013	1038	1063	1088	1113	1138	1163
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941	966	991	1016	1041	1066	1091	1116	1141	1166
942	967	992	1017	1042	1067	1092	1117	1142	1167
943	968	993	1018	1043	1068	1093	1118	1143	
944	969	994	1019	1044	1069	1094	1119	1144	
945	970	995	1020	1045	1070	1095	1120	1145	
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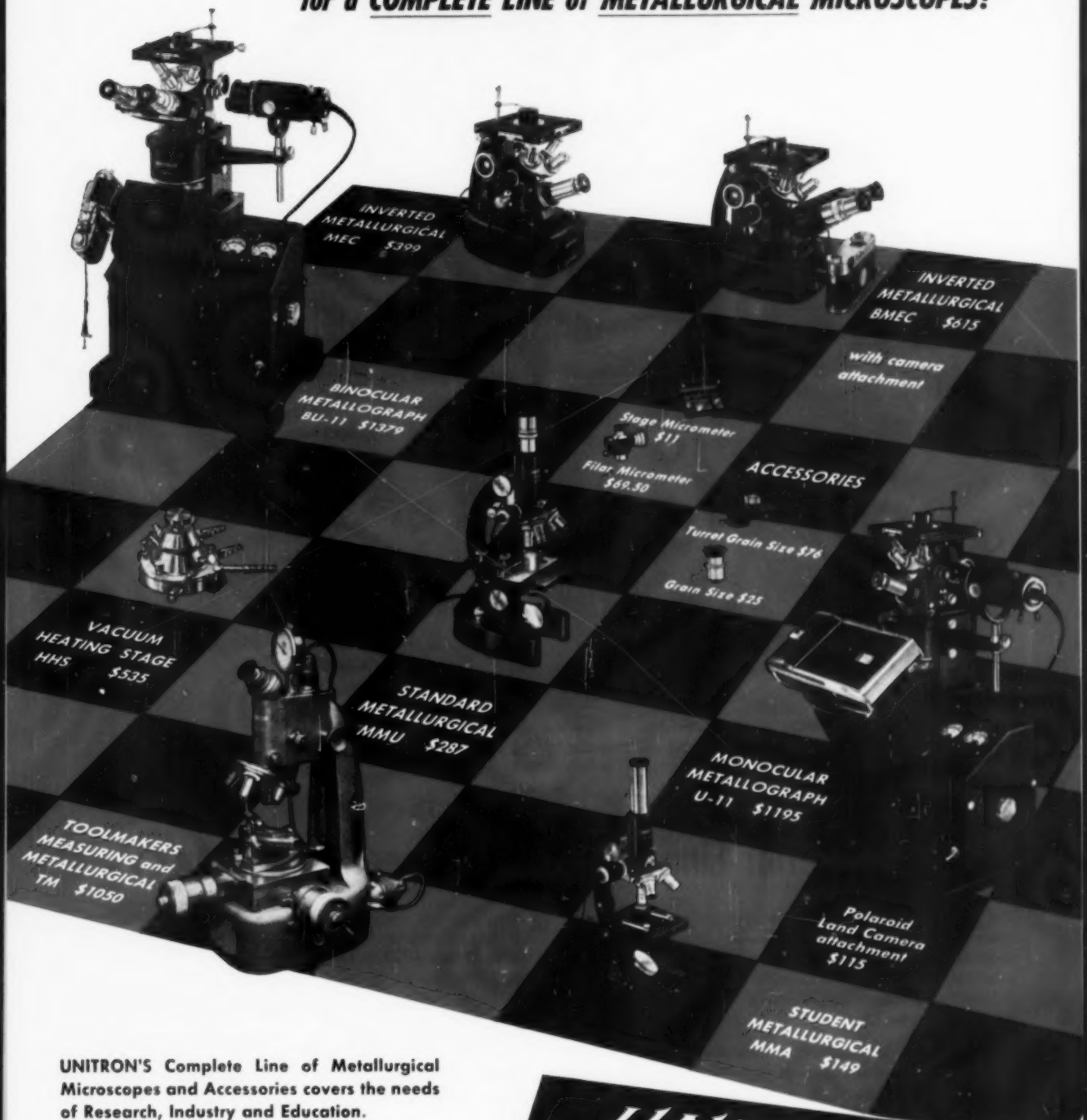

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Tubing of this new analysis is recommended for aircraft structural parts, studs and bushings, Bourdon springs and torque tubes in instrumentation, tubular springs, and hydraulic lines where severe bending and forming are required. It is available in WELDRAWN® form in size range from .012 through 1.125 in. OD.

In addition to PH 15-7 Mo, Superior offers the widest variety of analyses in the small-diameter tubing industry—over 120. This range permits you to specify the right one for your particular application. For complete information about PH 15-7 Mo and other analyses available for your needs, write Superior Tube Company, 2008 Germantown Ave., Norristown, Pa. *Reg. U.S. Pat. Off., Armco Steel Corp.

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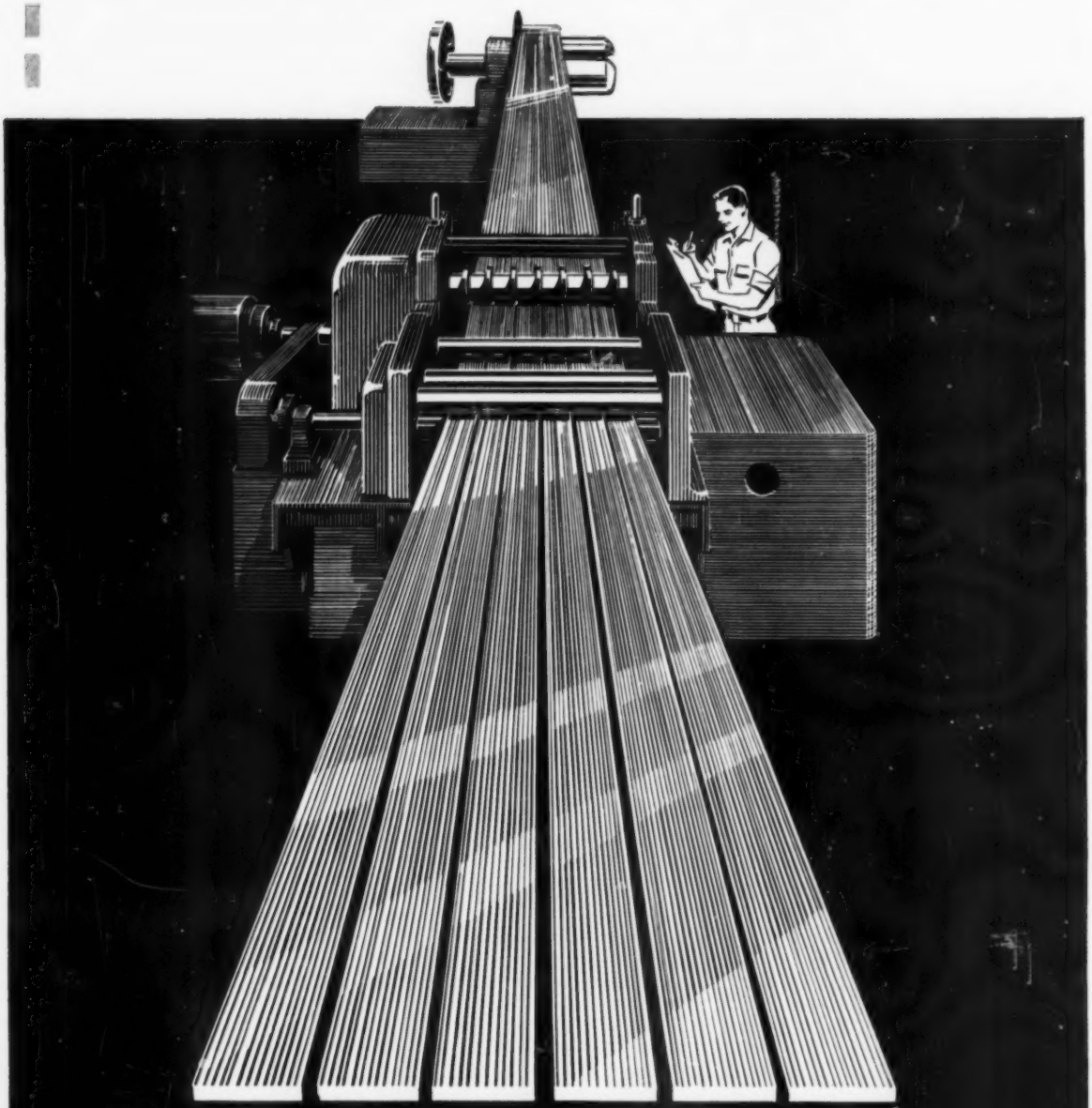

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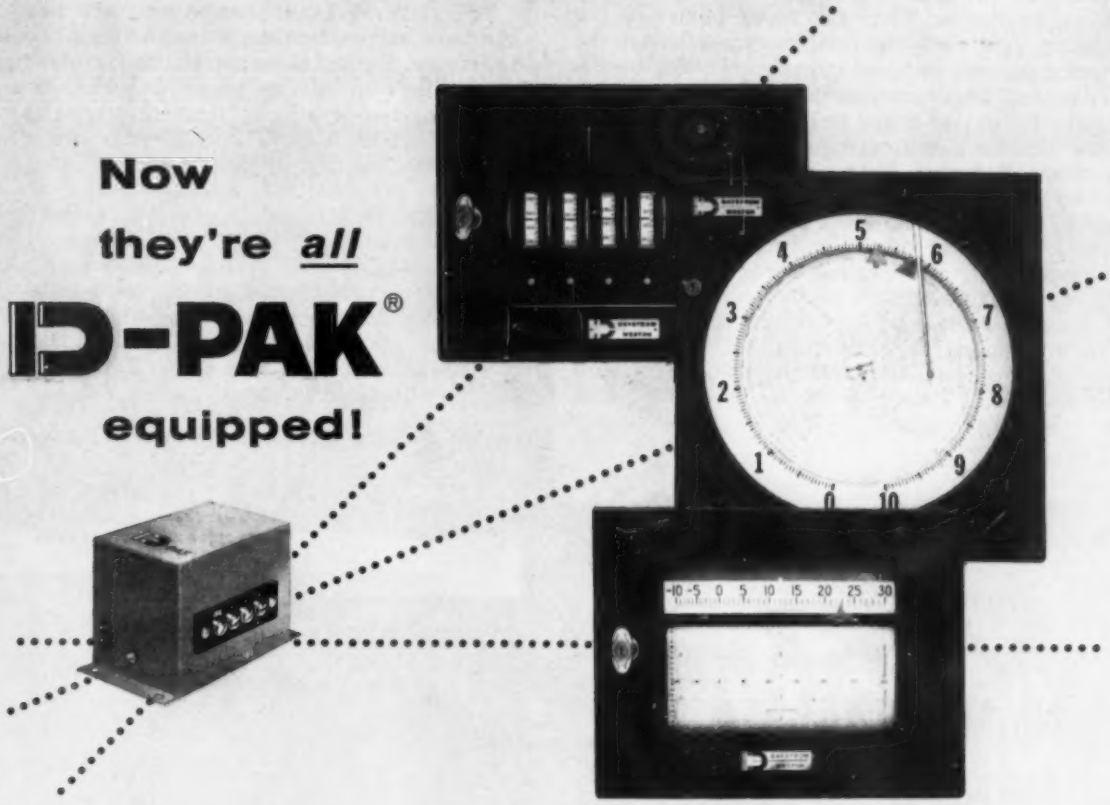

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DAYSTROM-WESTON INDUSTRIAL INSTRUMENTS include a full line of recording and controlling potentiometers with strip and circular charts; mechanical recorders and indicators for pressure, temperature and flow; and non-indicating controllers, both electric and pneumatic.

Failure of any part of a missile—be it the mighty Atlas, Jupiter or Thor—can mean failure of the mission. That's why the complex connections in the ducting systems of these and other missiles are silver brazed. These connections must stand up under 6,000 psi; they are tested to 12,000 psi.

In lines made to specifications by Flexonics Corporation, Maywood, Illinois, silver brazing joins a corrugated flexible pressure carrier, a braid sleeve and a coupling nipple—all of stainless steel; it permits joining all of these elements of the assembly without danger of annealing the pressure-carrying flex or the restraining braid as welding might do.

Assemblies designed for 6,000 psi operating pressure are required to withstand a 12,000 psi test and take four times their normal operating pressure before failure. They may also be required to pass a flame test in order to meet specifications.

The silver-brazed connections are used on hydraulic and pneumatic systems, fuel drain lines and vent tubes. Some of these applications involve rigorous service with extreme pressure shocks accompanied by sudden elevations of temperature, which may go from −60° to 400-600° F in a matter of seconds.

A more "high level" endorsement of Handy & Harman silver alloy brazing is not available. On the ground or in the air, the qualities of this remarkable metal joining method apply; strength, ease of production, cost, gas and liquid joint tightness to name a few. The entire brazing story is yours merely for the asking. Inquiries and metals-joining "problem exposure" may be addressed to Handy & Harman, 82 Fulton Street, New York 38, N. Y. We welcome the opportunity to work with you.

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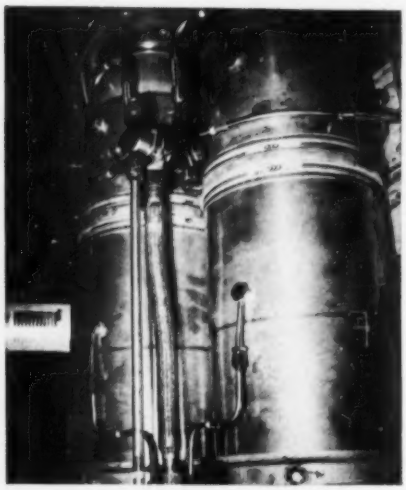
Assemblies in ATLAS Missile **HANDY & HARMAN** Silver Brazed

Intercontinental Atlas missile being made ready for launching.



Close-ups of missile section, showing silver alloy brazed ducting assembly.

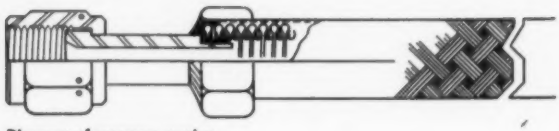


Diagram of pressure carrier.

FOR A GOOD START: BULLETIN 20.

This informative booklet gives a good picture of silver brazing and its benefits...includes details on alloys, heating methods, joint design and production techniques. Write for your copy.

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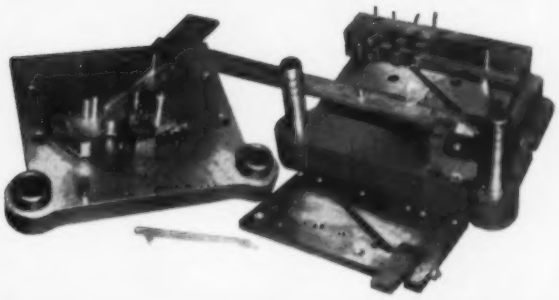

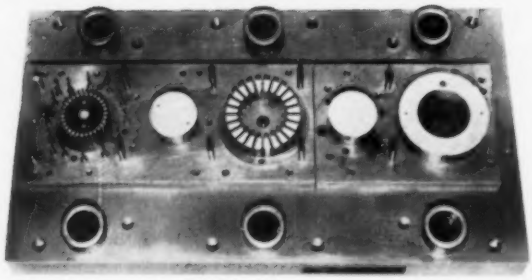

ohio die

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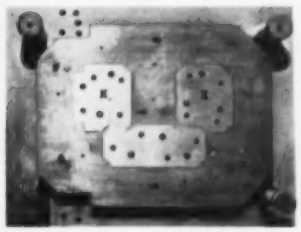

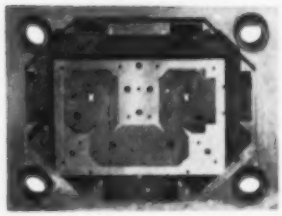

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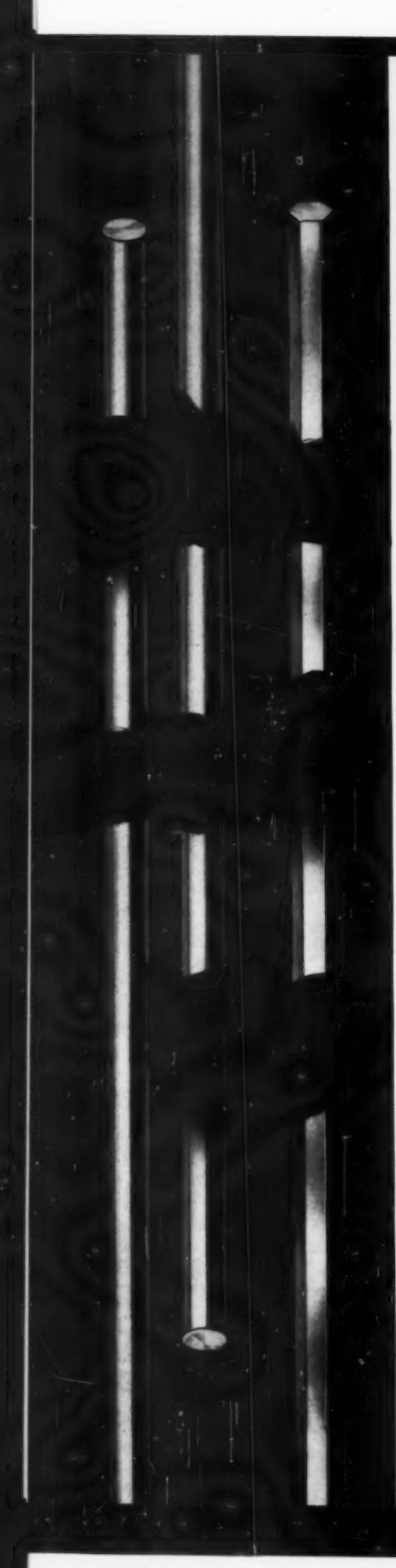

An announcement of interest to manufacturers of steel parts

Improvements in today's STRESSPROOF STEEL BARS WITH COPPER

1 **100,000 PSI YIELD STRENGTH** in all sizes . . . without heat treating.

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3 **IMPROVED MACHINABILITY...** STRESSPROOF with copper now machines faster and better than ever. It gives longer tool life, better finish, and more production from a day's run, according to shop production records.

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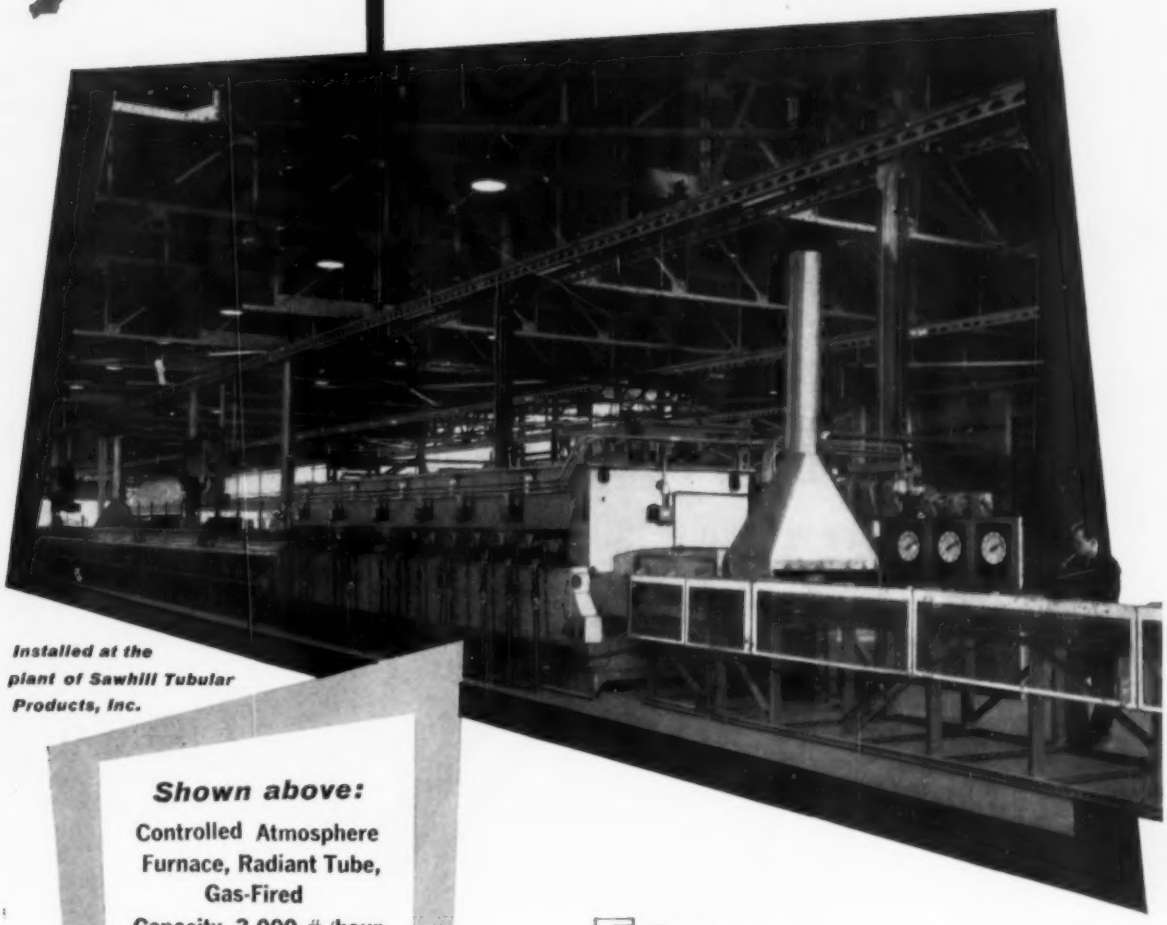

Installed at the plant of Sawhill Tubular Products, Inc.

Shown above:

Controlled Atmosphere Furnace, Radiant Tube, Gas-Fired

Capacity, 3,000 #/hour

Alloy Tubing ⅛" O.D. to 2½" O.D.

Overall, 176 ft. long x 7'-6" wide

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Gas or Electric Furnaces for Stainless Steel Annealing with or without Controlled Atmosphere

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Gas brazing is not new to Westfield, where Columbia bicycle frames have been brazed with Gas-fired Selas processing equipment for many years. During this time, pre-placing of brass filler material and automatic heating have limited dependence on operator skill, reduced material waste, and eliminated costly cleanup operations. With the installation of the new Gas brazing machine in their production operation, these advantages have been extended to include fork manufacture, also.

For information on how Gas equipment can help you in your production operations, call your Gas Company's industrial specialist. He'll be glad to discuss the economies and outstanding results you'll get with Gas and modern Gas equipment. *American Gas Association.*

Two fork styles in all standard bicycle sizes are joined from eight steel components on this new automatic Selas machine by Westfield Manufacturing Co., Westfield, Mass. Controlled combustion and flame geometry bring the parts to brazing temperature of 1750°F in only 86 seconds, using economical Gas equipment.

ferrous

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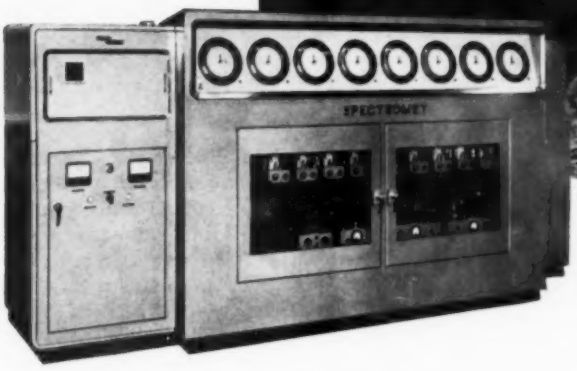

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The Baird-Atomic SPECTROMET allows high precision analysis of alloying and minor elements to be made quickly and easily. Results are reported to the melt shop in minutes permitting corrections to be made prior to pouring. The expanded SPECTROMET is specially designed for rugged, practical use . . . to be operated by non-technical personnel.

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- Results presented on indicator dials directly in percent concentration.
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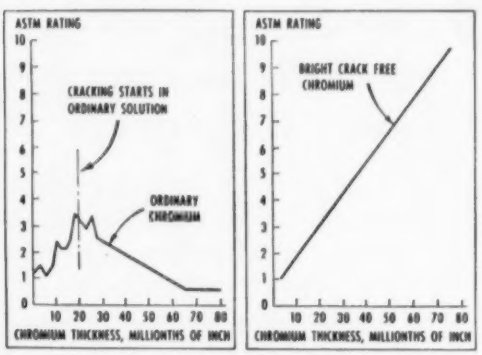
Thicker chromium plate increases corrosion protection

Thicker chromium in general, and Unichrome SRHS® and Crack-Free deposits especially, are doing more to increase protection against corrosion than any other change in decorative chromium plating in the past 25 years. Latest research demonstrates this.

As far back as 1928, it was shown that ordinary chromium plate soon reaches a critical thickness. (See graph A.) At a thickness of approximately .020 mils, the chromium cracks microscopically. Through these openings, corrosives can reach the



Graph A. Effect of increasing thickness of ordinary chromium on salt spray resistance . . . from Baker & Pinner data, SAE 1928. **Graph B.** Crack-Free Chromium ASTM corrosion ratings based on accelerated acetic acid salt spray tests.

undercoatings, and ultimately attack the base metal, ruining the appearance and function of the plated part.

Note, however, that before cracking commences, corrosion resistance *does* build up as the number of pores in the plate are reduced by the thicker deposit. Depending on undercoats, the effect of cracking can be modified.

DUCTILE CHROMIUM DOESN'T CRACK

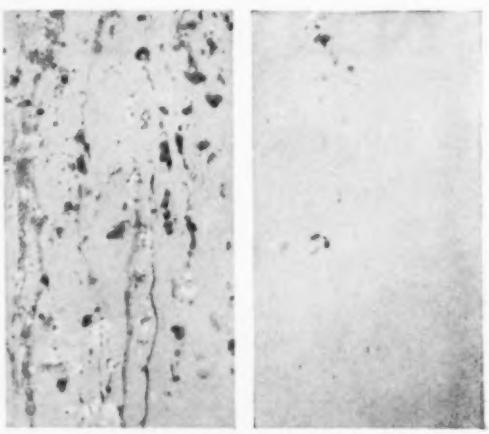
But see what happens in the case of Unichrome Bright Crack-Free Chromium. (Graph B.) An innovation in plating, it plates as thick as desired for practical purposes – entirely without cracks – and, as thickness increases, corrosion-admitting pores are eliminated. Protection keeps rising.

BETTER PROTECTION IN RECESSES

In the past, corrosion usually appeared in recessed areas of parts where little or no chromium could be plated to protect the base metal. This problem, too, is solved by Unichrome Bright Crack-Free Chromium which gives much better coverage and throwing power than previous processes.

LOW COST

The corrosion protection of decorative chromium can be improved several ways. Unichrome Crack-Free Chromium can be used alone or in combination with other fast plating SRHS chromium processes. Combination of chromium deposits, impossible from a practical standpoint for 25 years, is now done commercially with SRHS and Crack-Free Chromium, thereby eliminating need for new, larger tanks and saving thousands of equipment dollars.



Effect of thickness of CRACK-FREE Chromium over thin undercoatings (0.4 mil Nickel on steel) after 48 hours CASS test. Left – 0.015 mil Chromium; right – 0.045 mil Chromium.

A technical paper, "Thicker Decorative Chromium for Better Corrosion Resistance" gives more details. Write for your copy. METAL & THERMIT Corporation, Rahway, New Jersey.

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The unique experience of our staff is reflected in our designs. We of course consider efficient loading, convenient handling, and functional operation with furnace mechanisms. Of equal importance to serviceability is the ENGINEERING evaluation of the complex stresses and deformations encountered in use at high temperatures, and in quenching. Atmosphere and quench circulation in critical part areas are given special attention.
An equal caliber of ENGINEERING is employed in our product manufacture—where our proprietary processes have received both national and international recognition.

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Ledloy 170 tubing is the world's fastest machining steel tubing—and only Ryerson has it available from stock. It's a cold-drawn, seamless product of low carbon analysis with .15% to .35% lead added. Sizes available to date: 1" to 2½" O.D. with maximum ⅜" wall thickness.

Ask your Ryerson representative for complete details on Ledloy 170 tubing —and new Ledloy 375, world's fastest machining bar stock. These two newest additions to Ryerson stocks supplement the already large supply of screw steels and leaded alloys for all applications.

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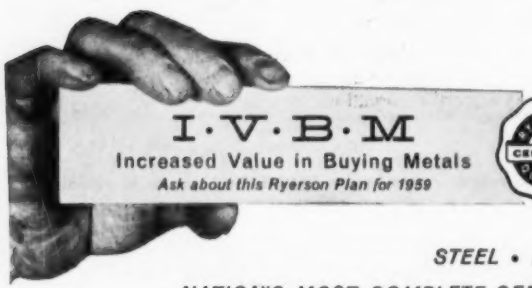

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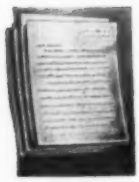
Metal Progress
Vol. 75, No. 5 May 1959

Critical Point

Peaceful Satellites

THE LAUNCHING of the weather satellite is a reassuring reminder that the conquest of space has constructive as well as destructive potentials. While our peaceful satellite is tiny in size compared with the Soviet Sputniks, it carries instruments for scanning a broad belt around the earth, reporting on cloud patterns that indicate the trend of the earth's weather. This gives hope for understanding how world-wide weather works, which could be a tremendous boon to mankind. Satellites for peaceful purposes will carry much more significance than the military ones, provided we can find a way to avoid using the latter.

Shortly after the first Sputnik began to orbit, Dr. Fred Whipple, director of the Smithsonian Astrophysical Observatory of Harvard University, said: "We have learned more in the past 10 days about astronomy than we have learned in the previous 200 years." That quote is included in "Utility of Space Flight", a prospectus compiled by D. W. Dreisig of Thompson Ramo Wooldridge, Inc., a company in the forefront of missile technology, actively interested in all aspects of space exploration. Mr. Dreisig obtained material from practically every source — declassified reports, science fiction(!), Russian newspapers and intelligence agents. Some of his suggestions for space research are given here to acquaint you with this rapidly growing field.

Though astronautics is still in the embryonic stage, Advanced Research Projects Agency of the United States Government has already been bombarded with some 200 proposals. As far as peacetime uses are concerned, they can be divided into five broad classifications: Geophysics, Meteorology, Astronomy, Biology and Communications, and each can be subdivided into many distinct programs. To complete all of the practical suggestions would take over 10 years and cost some 400 billion dollars, it is estimated!

The satellites were originally intended to supplement the program of the International Geophysical Year. Through orbit tracking, researchers recently found out that the earth is slightly pear-shaped! Is this important? Geophysicists claim it is; they say it will permit better determination of the earth's origin, history and structure. Other projects, well on their way, include research into air densities, electric currents in the ionosphere, solar ultraviolet and X-rays, cosmic rays, micro-meteorites, and hydrogen and ion densities. Satellites will also increase the accuracy of global maps.

In meteorology, satellites such as the Vanguard II's weather-eye already mentioned should be quite useful in forecasting, once techniques have been perfected. Weather prophets are still more artists than scientists, partly because less than 10% of the earth's surface is included in weather surveys. The future may put TV or optical equipment in weather satellites, 1000 to 4000 miles up, which could inventory the

clouds over the whole world every few hours. Other instruments might ascertain atmospheric temperature, rainy areas, solar radiation, and meteoric dust. At first, satellites would merely supplement traditional techniques; later, as instruments became more precise and durable, some of the more perilous detection services (weather ships, iceberg patrol, hurricane hunters, and so forth) could be honorably retired. Eventually satellites can be expected to gather a great deal of the data needed to forecast the weather.

Astronomers are looking forward to the day when they will be working with telescopes installed in satellites. Since Galileo's time they have been contending with gravitation and atmospheric diffusion. ("Twinkle, Twinkle, Little Star" could never have been written in space; out there, stars shine without a quaver.) Though this diffusion results in fuzzy images, the worst enemy of large telescopes on earth is gravitation. As the telescope turns to follow a dim star, the weight distribution through the concave mirror changes. This distorts the mirror and the image on the photographic plate is ruined. Furthermore, without gravitation to worry about, much larger mirrors are possible. One proposal mentions a 1000-in. mirror made of thermoplastic and weighing only 150 lb. Even one as small as a 100-in. mirror, built in space, could resolve distances of 10 miles on Mars.

Visible light is not the only radiation in which astronomers are interested. Stars emit the full range of electromagnetic waves – and the atmosphere either dims them or shuts them out completely. In space, all would be received and recorded with undiminished strength. So much is possible that astronomers hardly know where to start.

To most people, satellites appear to have their greatest value as units in a world-wide communications system. As relay stations, these space platforms would enable our television impresarios to display their wares throughout the world. This is not possible yet – and maybe it's just as well. Just imagine the impact some programs (like Howdy Doody and Strike It Rich) might have on international relations. At any rate, an international communication network is being talked about. In fact, the next few years may see one in operation. The recently developed atomic batteries are capable of extremely long life; a little further work, and they could power a relay station in a satellite for many months. Solar batteries have already been used to power satellite equipment. Tape recorders, such as the one that broadcast the President's Christmas message from the Atlas, could be used to pick up and send the messages. In time, radio and television signals could be relayed everywhere.

Imagine the effects of world-wide communications whereby stations could send their programs 12,000 miles as easily as 12 miles. Beyond the political effects would be the economic ones. Global advertising would be feasible. Vast new markets would be created by newly informed world population. Three or possibly four satellites spaced in an orbit 22,350 miles high could service every family in the world through radio communications.

Dr. John C. Evvard, assistant director of N.A.S.A.'s Lewis Research Center, proposes a "Western Union" satellite for transmitting messages to all parts of the world. It would be equipped with a two-way radio system and magnetic tape memory for recording and play-back. When the satellite passes over a ground transmitting station, it would receive, record and catalog messages according to the designated time for rebroadcast. Several such satellites and polar relay stations could send messages from any point on the earth's surface to any other point. The expense would be the same for a message to Moscow or to Panama.

Satellites can be employed as navigational aids. A satellite requires but 10 min. to move from horizon to horizon. The stars require 12 hr. Hence, the satellite could be used by ships to locate their position with 72-fold accuracy.

Tremendous areas of medical research might be explored in a satellite astronomical laboratory, suggests Dr. Evvard. The effects of weightlessness on life, possibilities for rest cures in the silence of space, effects of isolation on man's emotional stability, perhaps even the clue to life's origin lies in the radiations normally shielded by the atmosphere and the earth's magnetic field.

Certainly, satellite research offers breakthrough possibilities in many fields of science. Studies which at first may seem academic will invariably lead to a better understanding and utilization of the universe for the improvement of mankind. The role of the metals engineer in this exciting future is a vital one. He must provide the new metals and new techniques needed to produce vehicles which fly into the beyond. Without him, all the powerful fuels developed by the chemist and intricate instrumentation produced by the electronics expert would still be earth-bound.

Characteristic Green Flame Comes From Afterburner of J 57 Engine on Test Using an Exotic Fuel

Stress-Relieving Titanium Alloy Weldments

*By ROBERT P. BRODY and ALFRED A. TAYLOR**

Compressor cases made of 5% Al, 2.5% Sn titanium alloy cracked on stress-relieving. The problem was solved by altering the heating cycle. Previously heated in 200° F. increments, the case is now placed in a cold furnace and heated directly to 1150° F. (J1a; Ti-b, 7-51)

THE CONSTANT PUSH to lighten aircraft yet retain equivalent strength has focused attention on titanium alloys. As engineers have become more familiar with the properties of these alloys, they have tended to use them more and more. However, new uses often bring new problems.

An example at our plant was the appearance of cracks after stress-relieving a compressor case (Fig. 1) made of 5 Al, 2.5 Sn alloy. How this problem was solved is the subject of this report.

Fabricated from sheet metal and ring forgings, this complex part was welded by the tungsten-arc inert-gas process. Details of the vane and shroud subassembly are shown in Fig. 2. As can be seen, it is a complicated joining problem even for a skilled operator.

Selection of 5 Al, 2.5 Sn alloy for structural components of the Pratt & Whitney J 57 jet engine was based primarily on its outstanding strength-to-weight characteristics, corrosion resistance and weldability. Furthermore, the laboratory evaluated fusion welds and found that they satisfied all design requirements. To avoid contamination, all parts were welded in chambers filled with inert gas atmosphere.

Previous experience with stainless steel weldments had demonstrated that stress-relieving was needed after joining detail parts, and also after entire assemblies were welded. It was felt that titanium weldments would require similar treatment. Further, if this could be done in conventional air furnaces it would be more economical. Laboratory bend tests proved that the alloy could be heated in air to 1150° F. for 12 to 16 hr. before surface embrittlement started to occur from oxygen contamination.

The cycle initially used for weldments consisted of step heating to 1000° F., holding for 2 hr., then cooling slowly to room temperature. Eight hours was required for each stress-relief cycle, amounting to about 48 hr. of stress-relieving for fabrication of an entire weldment.

Troubles Develop

Despite the good weldability predicted by laboratory tests, and the stress-relief procedures used, the complex weldment cracked severely.

Most of the cracks occurred in fillet welds joining vanes to the shroud. There were also cracks in welds that joined the case to the shroud. After

*Respectively Project Metallurgist and Project Materials Testing Engineer, Materials Development Laboratory, Pratt & Whitney Aircraft, East Hartford, Conn.

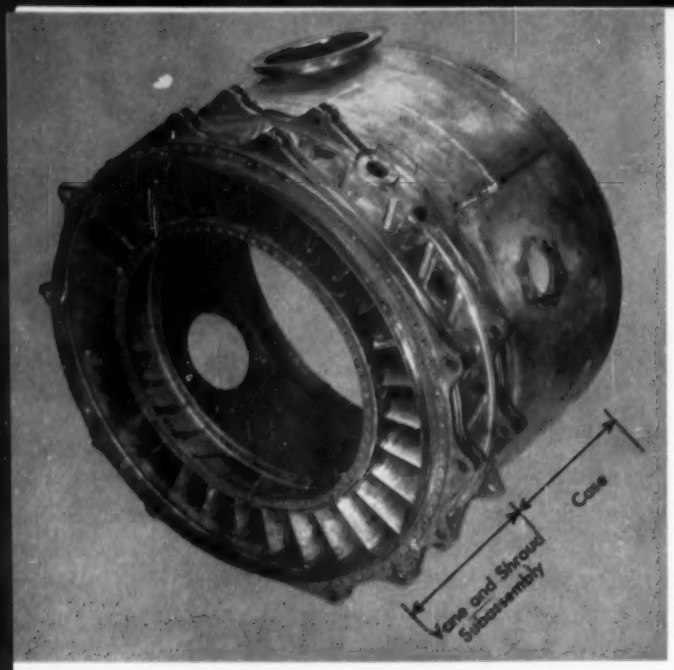


Fig. 1 – Intermediate Compressor Case for Pratt & Whitney Aircraft J 57 Engine. This is a complex weldment made from 5 Al, 2.5 Sn titanium alloy

Fig. 2 – Detail Parts of Vane and Shroud Subassembly. Most of the cracks appeared in the fillet welds, though some were present in the circumferential weld which joins the subassembly and case

stress-relieving at 1000° F., cracks were detected either visually or by pressure test. Because cracks developed after stress-relieving, several possible causes were considered. Two of these were investigated:

1. Degree of stress-relief produced by 1000° F. on unwelded sheet samples and on entire case weldment.
2. Effect of heating and cooling rates on residual stress distribution in the weldment.

Preliminary Stress-Relief Study

To begin the investigation, strips were stressed and evaluated by X-ray diffraction*. These specimens were heated for various periods of time at several temperatures. Changes in stress levels were determined for each condition.

There was some question about the relief of stress induced by various methods. For example, would welding stresses and shot-peening stresses be relieved by the same heat treatments? (In welding, the outer fibers could be in the elastic condition with tensile stresses. Conversely, after shot-peening, the outer fibers are in a plastic condition with compressive stresses.) To determine the answer, titanium strips (4 by 0.5 by 0.200 in. thick) were subjected to stresses by bending and by shot-peening.

Strain gages were attached to the bend test specimens, which were installed in a test rig (Fig. 3), and loaded in increments to tension of about 60,000 psi. Other stress specimens were peened with S-70 steel shot to compression of about 60,000 psi. All specimens were heated in argon atmosphere for ½, 2 and 4 hr. at 800, 1000,

*The X-ray technique was selected because stresses can be measured in about 15 min., and the same specimen can be analyzed before and after treatment. Very briefly, diffraction of X-rays by a crystal lattice determines interatomic spacings which change with applied elastic stresses. Therefore, by combining stress-strain and X-ray results, a quantitative analysis of stress can be determined from a change in spacing.

All stress data were taken with an X-ray diffractometer using a collimated beam of copper radiation at 45 kv. and 18 milli-amp. A 1° beam slit, with solar baffles removed, was used with two 0.010-in. receiving slits set 3 in. apart along the reflected beam filtered with 0.0006-in. nickel foil. Determinations were made on titanium (213) diffraction peak at 142° and at ψ angles of 0° and 45°. A calibration bar with strain gages installed indicated a stress constant of 640 psi. per 0.01° Δ 2θ at 142°. Peak position for calibration was determined by parabolic method. Peak positions (for stress measurements on strip specimens) were determined by "slope method".

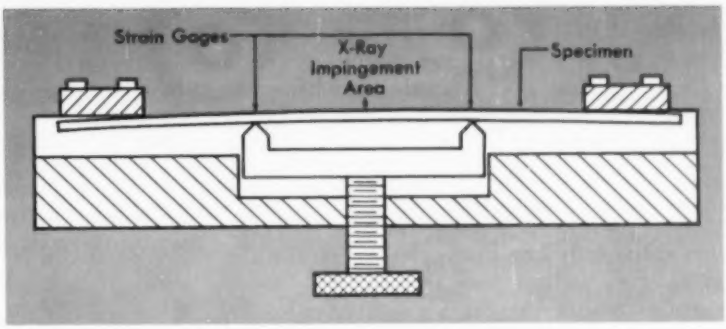


Fig. 3 – Test Rig for Titanium Strip Specimens. Bend stresses are induced by tightening the screw

1150 and 1300° F. X-ray measurements, taken before and after each treatment, showed that stresses were completely relieved after 2 hr. at 1000° F. In general, tension stresses were relieved at lower temperatures than compressive stresses.

Study of Case Weldment

After this preliminary work, experiments were conducted with the compressor case. For these tests, two 3 by 4-in. sheet metal sections were removed and two patches were welded at the circumferential weld which joined vane and shroud weldment to the rear case section. Strain gages were installed around these patches to measure stresses in the as-welded condition, and after each 2-hr. treatment at 1000, 1100, or 1200° F. (Fig. 4). Patches were cut out after each cycle, and changes in strain were recorded. Then, the patches were rewelded in place.

The case was put in a furnace below 400° F., heated to 600° F. within 45 min. and held at temperature for 30 min. Then, the case was raised to 800° F. within 30 min. for a 30-min. treatment. After the preheating, the furnace was set at 1000, 1100 or 1200° F. (30 min. to heat) and the case was held for 2 hr. Furnace cooling to 600° F. (by the same increments used for heating) followed, and air cooling to room temperature completed the treatment. Maximum stresses were found to be perpendicular to the weld, and 95% of welding stresses were relieved at 1200° F.

To further pinpoint an adequate stress-relief temperature, another patch was welded into the case. It was subjected to the same cycle, but at 1150° F. instead of 1200° F. for 2 hr. The 90% relief of stress which resulted was considered to be an acceptable level.

The higher temperature needed to stress-relieve the case (in contrast to that for strip specimens) was probably due to geometry of the test specimen. In general, it is believed that relief of stress occurs because of creep, or deformation and creep, or relaxation of stressed fibers. In strip specimens, both creep and deformation occur. However, radial deformation of case weldments is restrained by the hoop.

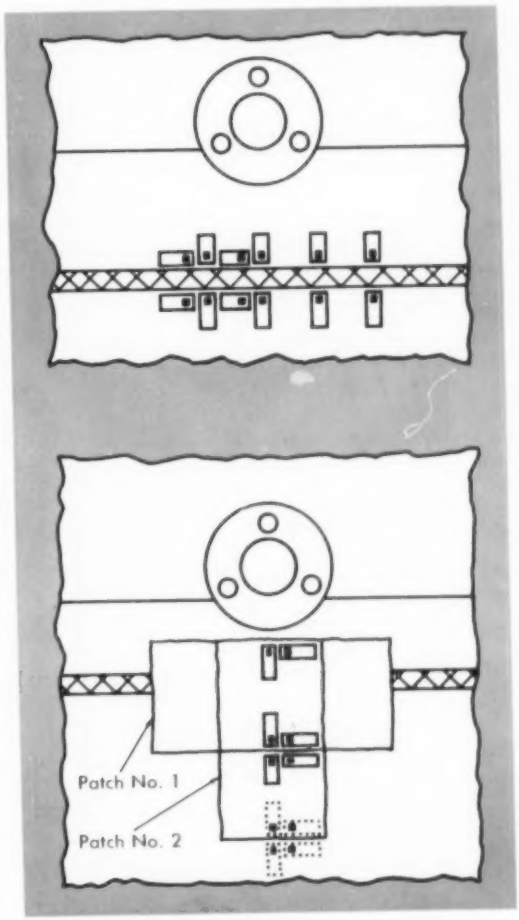


Fig. 4 – Locations of Strain Gages Around Machine Weld (Top) and Manual Fusion Weld (Bottom)

The poor thermal conductivity of the 5 Al, 2.5 Sn alloy at 1000° F. (96.12 Btu. per sq.ft. per hr. per in. per ° F.) caused some concern, since the 12% Cr stainless steel formerly used had over twice this conductivity. High stresses could easily be induced by high thermal gradients due to different thickness of the various detail parts.

This factor was studied by producing high thermal gradients in a case weldment. The case was put directly into a box-type electric furnace at 1150° F. without forced circulation. Since visual examination revealed a number of cracks in circumferential welds after this heat treatment, the initial furnace temperature was obviously an important factor.

To evaluate various heating and cooling cycles, a case was instrumented with thermocouples at various locations to measure temperature gradients. Thermal stresses could thus be estimated. Temperatures were recorded automatically.

Since it was believed that the beginning of each cycle was critical, measurements were made at intervals of 30 sec. during early stages. Later, measurements were recorded at 5-min. intervals.

In an electric bell-type furnace with forced air circulation, three basic heat cycles were evaluated. In the first, the case was placed in a cool furnace and heated to 1150° F. In the second, the case went into a hot furnace set at 1150° F. The third cycle consisted of step heating previously described. (This cycle had been used for case weldments prior to this investigation.) In conjunction with these tests, the effect of the case position on the supporting spider and the effect of a baffle which diverted the circulating air also were investigated.

What Tests on Thermal Gradients Showed

We found that the greatest thermal gradients occurred between the inner and outer shroud; maximum and minimum shroud temperatures are plotted for the three basic heating cycles (Fig. 5). Much information is required to calculate the maximum thermal stresses. It was necessary to know the radii of shrouds, temperature of shrouds at maximum temperature differential, vane length, vane temperature, vane cross-sectional area, and co-efficient of linear expansion of titanium. These calculated stress values (which give a nominal stress in the vanes) must be multiplied by a stress concentration factor because there is a change in section at the fillet weld between vane and shroud. Relying on previous experience, a factor of three was selected as the highest value that would normally be encountered in use.

Maximum stresses were located in vanes adjacent to fillet welds; the most severe cracking

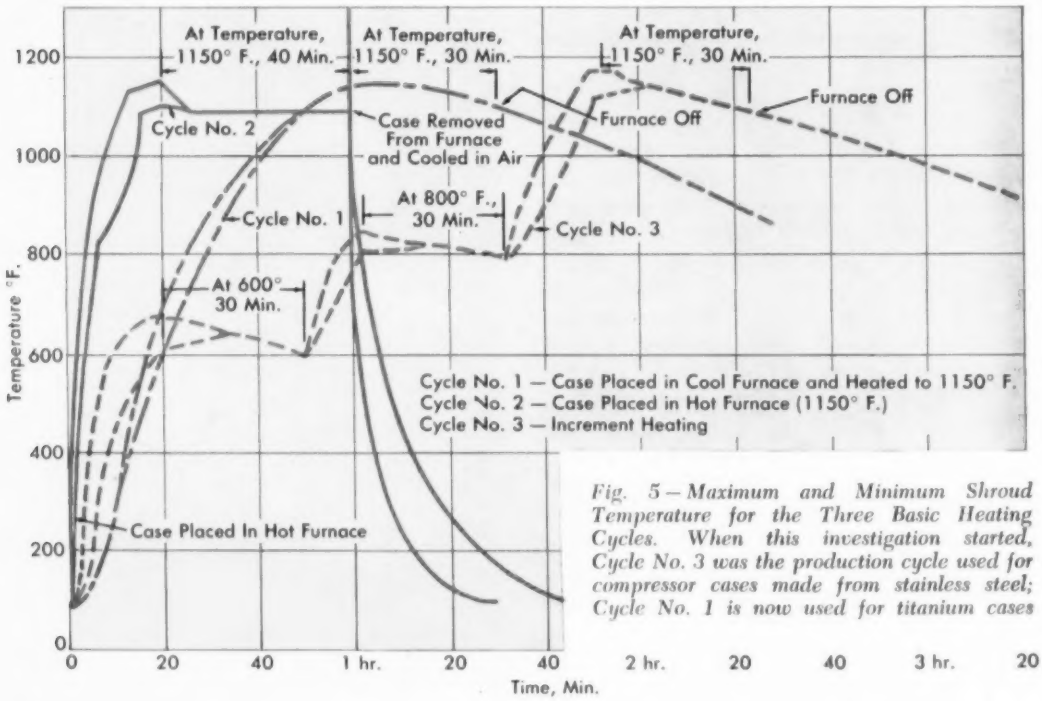


Fig. 5 — Maximum and Minimum Shroud Temperature for the Three Basic Heating Cycles. When this investigation started, Cycle No. 3 was the production cycle used for compressor cases made from stainless steel; Cycle No. 1 is now used for titanium cases

occurred there. For this reason, heating cycles were compared by plotting thermal stresses produced at fillet weld joints between the vane and shroud (see Fig. 6).

The lowest thermal stress, about 8,000 psi., occurred when the case was placed in a cold furnace and heated to temperature with forced air circulation. When the case was placed in a hot furnace, the highest stress, about 45,000 psi., resulted. Extensive cracking was also noted. Increment heating (causing some 20,000 psi. stress) produced a wide thermal difference between the various details when temperature was raised to the next step in the cycle. Position of the case on the spider appeared to be important, since more uniform heating occurred when the heavier section of the assembly (the vane and shroud weldment) was positioned on top or away from the spider. This is probably related to the characteristics of the particular furnace employed. No beneficial effect was gained by using a baffle to divert the circulating air.

The first 5 min. of the heating cycle was most critical; the largest temperature differential (and resulting thermal stress) was recorded at this time. Because residual welding stresses are not sufficiently relieved after 5 min., thermal stresses are added to welding stresses. The highest residual welding stress which was recorded was 90,000 psi. in tension. Add this to the highest calculated thermal stress of 45,000 psi. and the total stress comes to about 135,000 psi. This value exceeds the tensile strength of the material. Local cracks in these areas could be expected, and actually did occur. It follows that, if thermal stresses could be held at a minimum during the heating cycle, the possibility of local cracking would be considerably reduced. This was accomplished by heating from room temperature. After 1 to 2 hr. at 1150° F., residual welding stresses were eliminated, and the thermal stresses developed during the cooling cycle were not large enough to cause trouble.

Conclusions

1. A stress-relieving treatment of 1150° F. for 1 to 2 hr. is adequate for the 5% Al, 2.5% Sn titanium alloy.
2. Thermal stresses in a complex weldment are reduced by placing the part in a cold furnace and heating to desired temperature.
3. Position of the weldment in the furnace and type of circulation are important in avoiding additional themal stresses.
4. A full-scale weldment should be used for evaluating residual welding and thermal stresses because stress development depends upon configuration as well as rate of heating.
5. Total furnace time for stress-relieving was halved (reduced from 48 to 24 hr.).

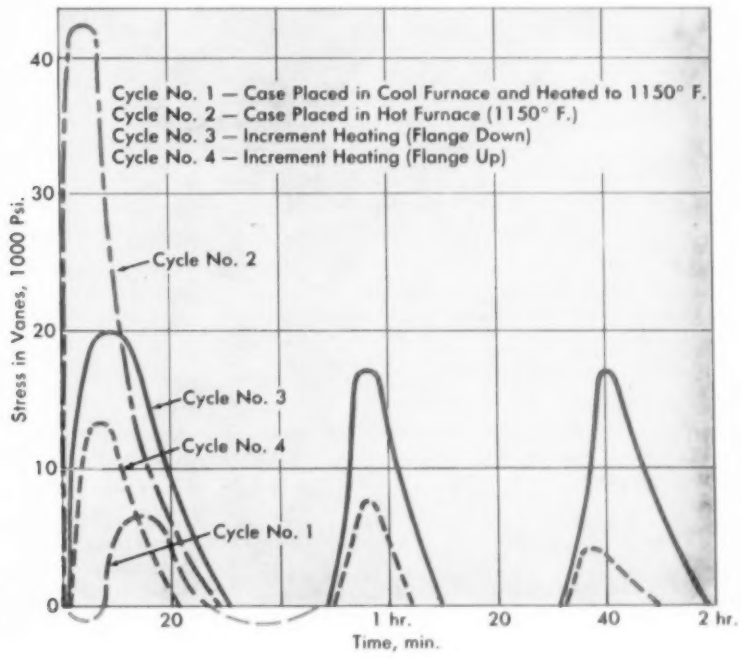


Fig. 6 — Calculated Thermal Stresses Produced in Vanes During Four Heating Cycles

New Techniques for Testing

Analyzing Segregates by Spectrograph

*By J. K. HURWITZ**

A motor-driven specimen stage and photographic plate enable continuous analyses to be made across segregated zones in polished samples. Banded structures, welds and nonmetallic inclusions can be readily analyzed by this method. (S11k, 9-69)

SEGREGATION, either inherent in the material or developed by processing, is often the source of subsequent troubles. In most instances, analysis of these segregates would help to solve a particular problem and suggest a future course of action. However, present-day methods make it difficult to analyze the small, thin areas that segregates normally occupy. Though the spectrograph is generally used because the material in the segregate is much too limited to be analyzed by standard wet methods, the resulting analysis is often obscured by that of the base metal when the segregate is "spotted" by the arc. The results may thus be indefinite and not of much value.

We, like others, have been faced with segregate problems for many years. To solve some of these, we recently modified our existing spectrographic equipment. The basic difference between our technique and conventional spectrographic analysis is that the sample and photographic plate are moved at fixed speeds while the spectrum is recorded. (Normally, these are stationary.) Hence a continuous record is produced of the differences in composition across the segregated zone. Figure 1 shows the gear and chain drives in position beside the spectrograph; they move the sample stand and spectrograph plate holder. The equipment accommodates flat samples. The counter electrode is a ⅛-in. diameter pointed silver rod of 99.99% purity. This is adequate for the application and is readily available. Silver is used instead of the more

*Applied Research Laboratory, United States Steel Corp., Monroeville, Pa. (formerly with the Canadian Department of Mines and Technical Surveys). This article is published by permission of the Director, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Ont., Canada.

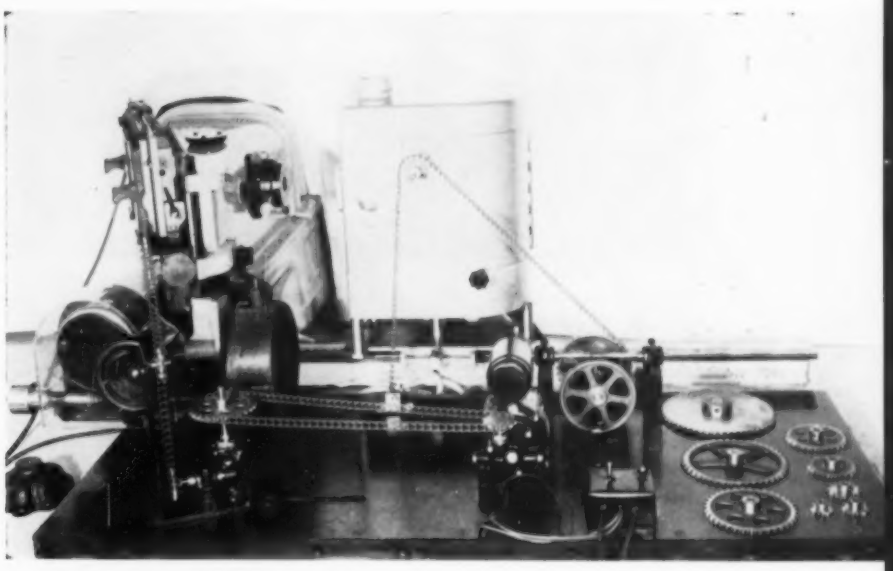
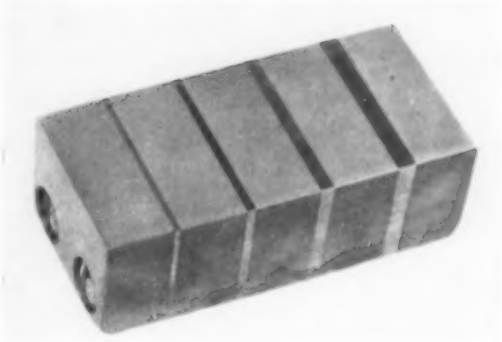


Fig. 1 — Gear and Chain Drive for Segregate Analysis. During analysis, the sample stage and photograph plate are moving; this enables continuous traversal across the segregated zone

usual graphite because it wears away more slowly in the spark discharge. As of now, our equipment permits a distance of ¾ in. to be traversed on the sample. The discharge is localized by using a narrow spacing of 0.015 in. between the counter electrode and the sample.

Procedure

A photograph of the polished and etched sample surface is taken on a light microscope at low magnification, say 10 ×, and the segregate position noted. After repolishing to remove the etched surface, the sample is traversed over the spark discharge to record the spectrum. It is then lightly polished, etched and again photographed at the magnification used before. The spectrographic plate is processed by standard procedures, and placed in the densitometer for intensity measurements. Because this plate has been moved during the traverse, the recorded spectral lines can be up to 2½ in. long. As many as 55 readings are possible along each spectral line. The distance of each reading from the beginning of the traverse is also noted. Subsequent calculations are the same as those made



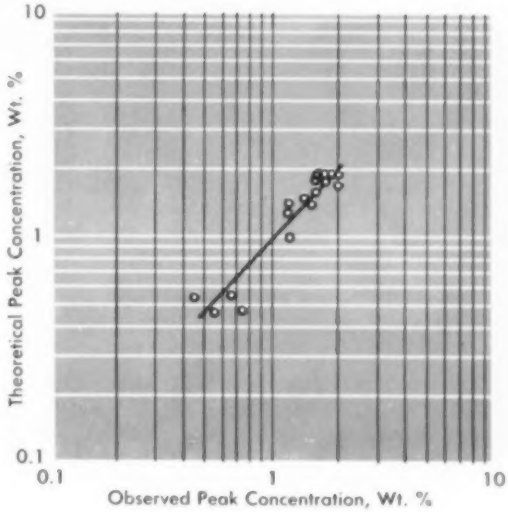


Fig. 2 — Artificial Segregates Composed of Thin High-Chromium Steel Plates and Thick Low-Chromium Steel Plates. Chromium content of thin plates is 1.91%; indicated analysis varies with thickness. Graph shows predicted chromium concentration opposed to observed concentration

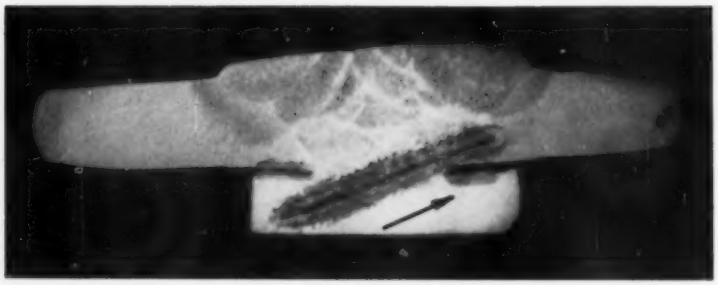
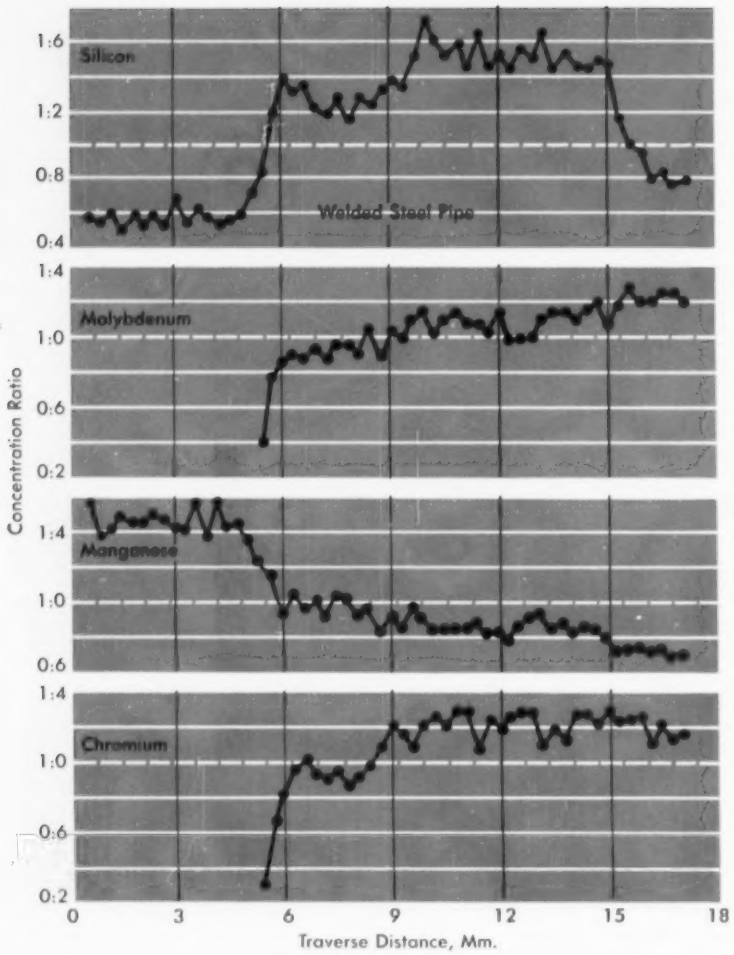


Fig. 3 – Traversal Across Pipe Weld and Steel Backing. Note variation in analysis as weld zone is crossed



in conventional spectrochemistry with the final results being reported as a graph of element concentration against distance on the sample.

During development of the technique, we needed to determine how well the equipment would follow abrupt changes in composition. We found this to be a function of several instrumental variables which could be measured – the major one being the size and shape of the crater produced by the spark discharge. A mathematical theory was evolved* to predict the changes in intensity (and therefore in concentration) recorded when a sharp boundary was

*"Spectrographic Analysis of Segregates With a Dynamic Microvolume Technique", by J. K. Hurwitz, *Spectrochimica Acta*, Vol. 9, 1957, p. 3-18.

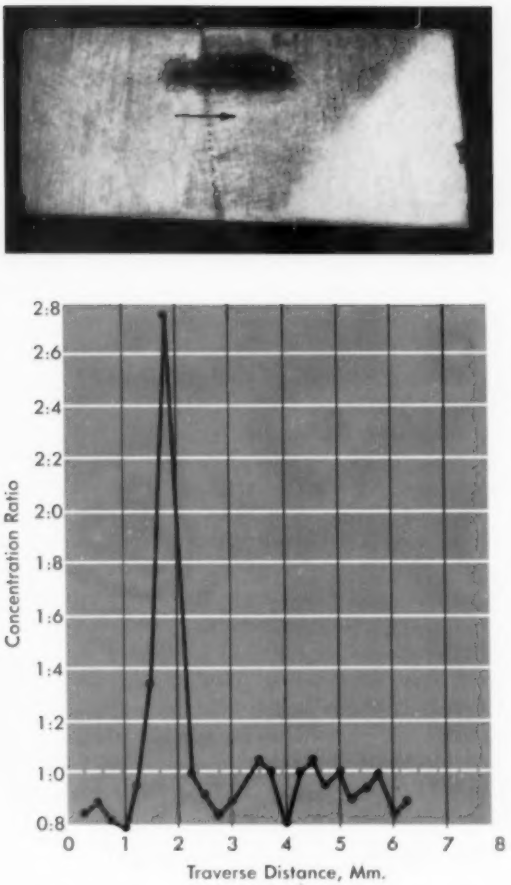


Fig. 4 — Manganese Segregation in a Forged Titanium Alloy C-130 AM. High manganese produces "alpha-prime" coarse-grained region

crossed. To test this theory, as well as the effectiveness of the technique, we clamped a series of 1.91% chromium steel plates as thin as 0.003 in. between thick 0.24% chromium steel sections. This formed a series of artificial segregates. Figure 2 shows the block and the results obtained by a spectrographic traverse across this block. The coefficient of variation between predicted and actual results is 7% with no bias indicated by statistical tests.

Applications

This spectrographic technique has been used to solve several trouble-shooting problems concerning both ferrous and nonferrous materials.

One example is a welding problem which involved the use of mild steel backing rings in the welding of 6-in. diameter chromium-molybdenum steel pipes for a critical high-temperature application. Although the backing rings were to be machined out after welding, we needed to know the extent of dilution in the weld deposit caused by melting of the mild steel, alloy electrode and pipe material at the weld root. Figure 3 illustrates the traversed section through the pipe, weld and backing ring; results for chromium, molybdenum, manganese and silicon are also shown. The traverse proceeds from the mild steel backing ring, through the first and second passes of the weld deposit, and into the pipe. Dilution by the metal in the backing ring is indicated in the lower portion of the first pass by a 20% decrease in chromium, molybdenum and silicon and a similar increase in manganese. After removal of the backing ring, only the upper portion of the first beads remained; this upper portion, now exposed at the root, was found to be undiluted. As a result, this use of removable mild steel backing rings was approved for high-temperature pipe fabrication.

Segregation can be a problem in many titanium alloys, in particular, C-130 AM (4% Al, 4% Mn). Gas turbine compressor blades are often forged from this alloy. The local manganese concentration may be high enough to lower the transformation temperature so that when the metal is heated to forging temperature, this segregated area transforms completely to beta (β), rather than retaining some alpha (α) which is the normal condition. This causes grain growth in the localized area and, if forging is completed while this segregated zone is still in the beta condition, subsequent transformation on cooling may create a coarse, brittle, "alpha-prime" (α') structure. Such regions appear as bands in the finished blades. One prominent band was found to run the length of a blade submitted to the laboratory. A section (Fig. 4) cut from the blade was traversed, and the results indicate a severe increase in manganese content of the band over that present in the rest of the blade. Correcting for the width of the band, a concentration of over 20% manganese was determined. This is far greater than the 6% manganese needed to produce the coarse-grained structure.

Conclusion

In summation, we feel that this technique has several advantages. Conventional equipment requires little modification and is easy to use. Analysis is rapid, accurate, and can be obtained on segregates as small as 0.003 in. with little difficulty. The method should be of much value in the future.

Impact Test for Evaluating Toolsteels

*By GARY STEVEN**

A shallow (½-in. radius) notch in the standard Charpy impact specimen is suitable for rating toughness of hardened toolsteels. Several different grades are compared along with the effects of various heat treatments on a single grade (M-2). (Q6r; TS)

CONVENTIONAL impact tests, such as Charpy V-notch and Charpy keyhole notch, are not suitable for rating the toughness of hardened toolsteels. In general, these steels are heat treated to such high hardnesses (Rockwell C-58 to 65) that they all have brittle fractures and cannot be compared. A different test is required to rate the toughness.

What an Impact Test Needs

Through the years, several tests have been devised to meet the requirements of toolsteels. These include unnotched impact, torsion, torsion-impact, bend and falling-weight impact test. Each test has drawbacks. The unnotched specimens produce test data that are widely scattered. Furthermore, because of the high energy required to fracture the more ductile materials, the test can damage the impact machine. The other test methods, although very useful for specific applications, also have limitations. The torsion test and the bend test require a careful set up, are expensive to conduct and can only be used at room temperature.

At Crucible, we came to the conclusion that a single standardized procedure for rating toolsteels was needed. This test should compare the toughness of different classes of toolsteels and also differentiate between the toughness produced in the same steel by different heat treatments. Furthermore, the test should permit toughness comparisons at elevated temperatures, be inexpensive and yield reproducible results with acceptable scatter.

How the Charpy Test Was Modified

Since values produced by the Charpy V-notch test are too low to be significant and the un-

Table I – Impact Strength of Tungsten and Molybdenum-Base Toolsteels

A.I.S.I. Type	Rockwell Hardness*	Impact Energy†	
		Room Temperature	1000° F.
	Tungsten-Base		
T-1	C-65	9 ft-lb.	15
T-4	65	6	13
T-5	66	4	9
T-6	65	3	6
T-8	66	4	8
T-9	66	9	12
	Molybdenum-Base		
M-1	64	15	26
M-2	64	21	35
M2-S	64	15	21
M-3	65	9	16
M-10 modified	64	13	22

*Commercial heat treatments were used throughout this test.

†All values are averages of three or more tests.

*Supervisor, Central Research Laboratory, Crucible Steel Co. of America, Pittsburgh. The author gratefully acknowledges the invaluable assistance of A. E. Nehrenberg, section engineer, technical development, and V. K. Chandhok, staff engineer, in preparing this report.

notched impact test results in wide scatter, an intermediate notch radius was investigated. If we could lower the stress concentration (below that produced by the standard 0.010-in. radius), we might obtain greater spread in impact value for different toolsteels. To test this assumption, modified Charpy impact specimens from six toolsteels were machined with ⅛, ¼, ½, and 1-in. cylindrical notch radii. These specimens are illustrated in Fig. 1 showing the ½-in. notch. The steels had been forged into ⅝-in. square bars, annealed, and rough-machined into 0.45-in. square blanks, 2.2 in. long. After heat treatment, the specimens were finished on all sides, and the different notch radii were ground into the hardened specimens with a contour grinding wheel also shown in Fig. 1. Since the transverse striations left in the notch surface could act detrimentally as stress-raisers, the notch was polished circumferentially.

For consistent test results, the specimen had to be carefully aligned and centered. Therefore,

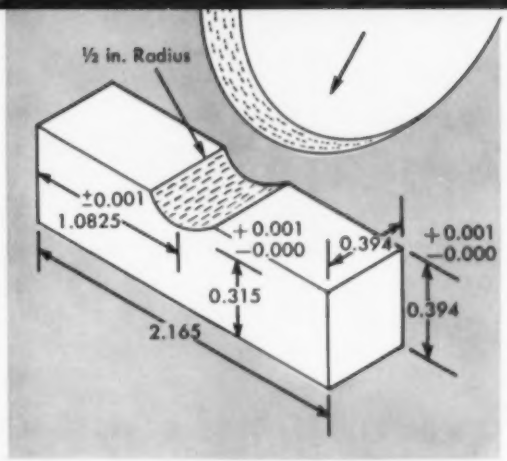


Fig. 1 – Standard Charpy Test With ½-In. Notch Substituted for V-Notch. A contour wheel grinds the notch, and transverse striations are subsequently removed by polishing with a ¾-in. diameter medium india stone

the distance from the end face to notch radius-centerline was held to ± 0.001 in. During the test, specimens were positioned against the surface ground stop of the holding fixture in the machine. (*Continued on p. 188*)

Table II – Impact Strength of Different Toolsteel Classes

A.I.S.I. Type	Austenitizing Temperature	Quench	Rockwell Hardness	Impact Energy*		
				−100° F.	Room Temperature	300° F
W 1	1450° F.	Brine	C-62	—	14	—
D-2S	1850	Air	62	—	16	—
W 4	1450	Brine	63	—	20	—
D-2	1850	Air	62	—	20	—
O 1	1475	Oil	63	20	28	39
A 2-S	1800	Air	62	20	28	33
A-2	1750	Air	61	—	28	—
S-5	1600	Oil	59	23	96	135
H-21	2150	Air	51	33	153	198
LaBelle HT†	1700	Oil	56	164	176	164

*All values are averages of two or more tests.
†Carbon 0.45%, Mn 1.35, Si 2.30, Cr 1.40, V 0.30, Mo 0.40.

Table III – Impact Strength of M-2 Toolsteel With Various Heat Treatments

Heat Treatment		Rockwell Hardness	Impact Energy†							
Austenitized*	Tempered		Room Temp.	300° F.	500°	600°	700°	800°	900°	1000°
2225° F., 10 min.	600° F., 2 hr.	C-61	30	35	42	39	43	41	43	—
	900° F., 2 hr.	63	20	28	35	37	40	38	42	—
	1000° F., 2 hr.	66	17	13	21	26	28	29	24	—
	1050° F., 2 hr.	65	19	23	29	28	29	32	32	38
	1100° F., 2 hr.	63	21	24	22	28	—	27	32	37
2075° F., 10 min.	1050° F., 2 hr.	60	31	—	—	—	—	—	41	—
2175° F., 10 min.	1050° F., 2 hr.	63	20	—	—	30	—	—	31	—
2275° F., 10 min.	1050° F., 2 hr.	64	5	—	—	7	—	—	9	—

*All specimen blanks were oil quenched from the austenitizing temperature.
†All values are averages of three or more tests.

New Techniques for Testing

Rating Heat Transfer Surfaces for Corrosion

By N. D. GROVES
and C. M. EISENBROWN*

A new test can accurately determine weight loss of a metal immersed in a corrosive solution. Specimen and corrodent can be maintained at different temperatures simulating heat transfer conditions. A typical problem in heat exchanger design is solved with curves developed from this test. (R11a, R6g; SS)

THE AVERAGE strong acid – sulphuric or fuming nitric, for instance – readily attacks most metals and alloys, as do also many basic solutions and liquid metals. Yet, modern industry uses tons of such materials daily. How are these corrosive liquids to be handled? Can engineers depend on present-day data for the design of adequate piping and containers? Unfortunately, the answer is usually "No".

Most available corrosion information is based on tests in which coupons are immersed in a corrosive solution (corrodent) held at a constant temperature. These tests do not duplicate true conditions, and, in fact, may be sufficiently inaccurate to cause serious errors in design. The need for better test procedures is apparent. We feel it is answered by the test apparatus shown in Fig. 1 and 2. Developed by N. D. Groves while employed by the General Electric Co., Richland, Wash., it was used to predict the life of heat transfer surfaces in service in atomic energy installations. The metal under study is maintained at a temperature above that of the corroding solution, thus, heat is transferred *to* the solution, and heat transfer surfaces are simulated.

*Corrosion Engineer and Chemist, respectively, Corrosion Research Laboratory, Carpenter Steel Co., Reading, Pa.

Equipment

A reaction vessel which holds the corrodent is wound with a resistance heater to supply extra heat when required. Attached to the bottom is a metal specimen heated externally by a 550-w. soldering iron. A thermocouple at the midpoint of the specimen measures the metal temperature, while another thermocouple in the vessel determines solution temperature.

This apparatus was used to investigate Carpenter Stainless No. 20-Cb as a heat transfer surface in sulphuric acid. Previously, the most useful information available came from tests in which coupons of the alloy were exposed in various concentrations of boiling sulphuric acid. Obviously, these data were usable when the material was intended for handling boiling sulphuric acid. If the alloy was used as a heat transfer surface, corrosion rates could not be predicted.

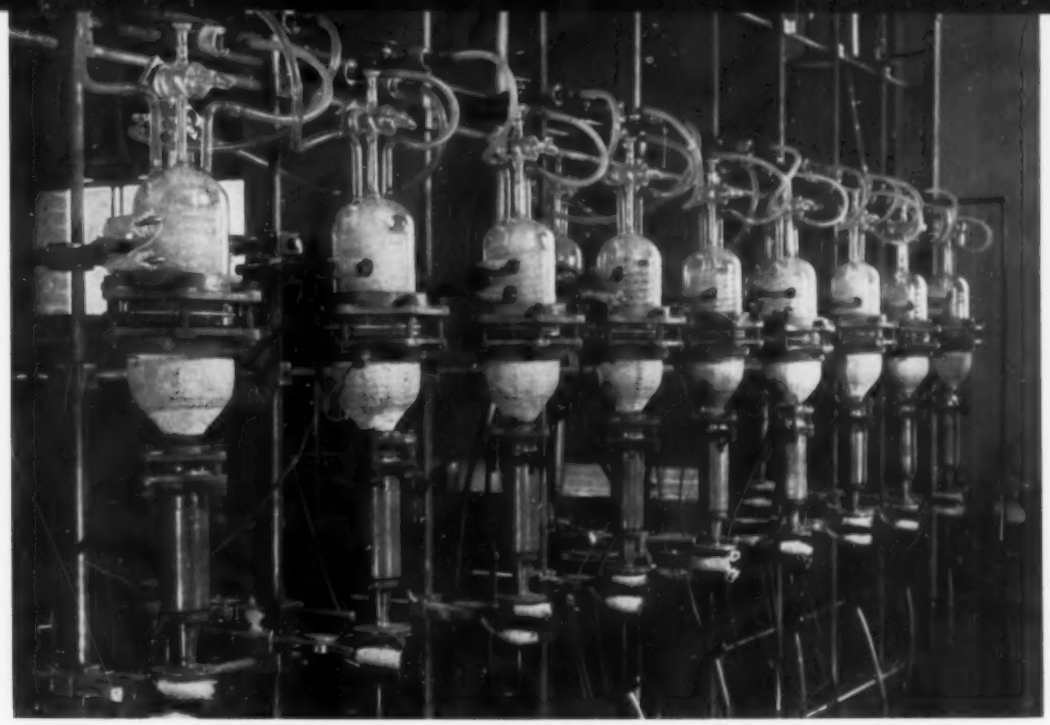
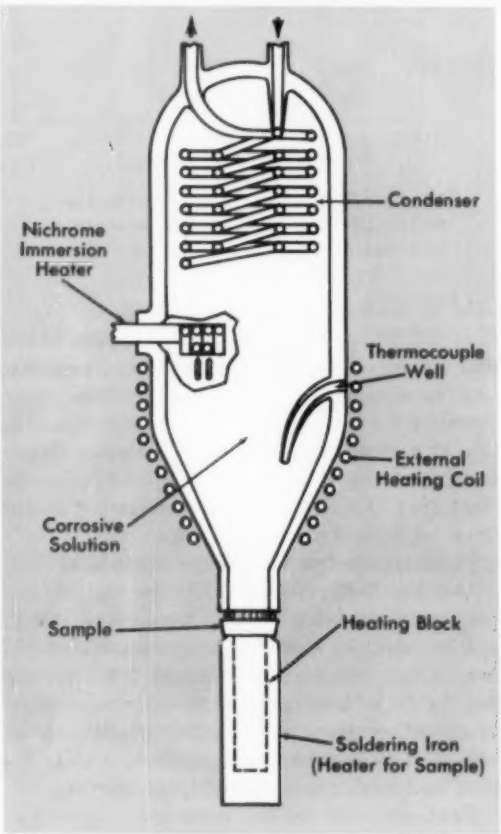


Fig. 1 — Battery of Corrosion Testers. Soldering iron maintains specimen at desired temperature, while resistance coil heats corrodent. Thus, specimen and corrodent can be kept at different temperatures during test

Fig. 2 — Sketch of Corrosion Tester. Disk sample is drilled, edge to center, for thermocouple



To begin the work, specimens (1½ in. diameter by 3/16 in. thick) were cut from plate which has the following chemical composition: 0.06% C, 0.82 Mn, 0.58 Si, 0.010 P, 0.005 S, 20.15 Cr, 28.57 Ni, 2.11 Mo, 3.31 Cu, 0.82 Cb. These specimens were annealed for 30 min. at 1950° F. and water quenched. After surfaces were ground parallel, the samples were stress-relieved at 1950° F. for 5 min. and quenched in an air blast. They were then electropolished (to remove surface oxide), passivated in 20% nitric acid at 150° F. for 20 min., weighed and placed in the test units.

For the corrodent, chemically pure sulphuric acid was diluted with varying amounts of distilled water to produce selected concentrations, all of which boiled in the range 215 to 225° F. Every 48 hr. the acid was replaced with fresh acid to minimize build up of corrosion products. Volume of solution in cc. was 150 times the area of sample exposed in sq.cm.

All tests were run for 240 hr., after which the units were disassembled. Samples were cleaned, dried and weighed, and corrosion rates calculated by the formula:

$$\text{mpy.} = \frac{3{,}451{,}000\ \text{L}}{\text{A T d}}$$

where mpy. = mils loss per year, L = weight lost in grams, A = area of sample (sq.cm.), T = time in hr. and d = density (g. per cc.) This can

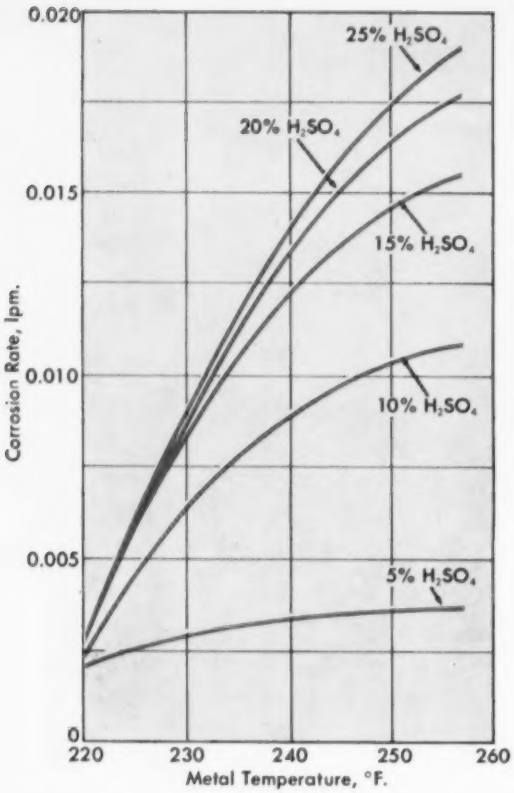


Fig. 3 — Corrosion of Annealed Carpenter No. 20-Cb at Various Acid Concentrations as a Function of Metal Temperature. Note the interdependence of temperature and acid concentration

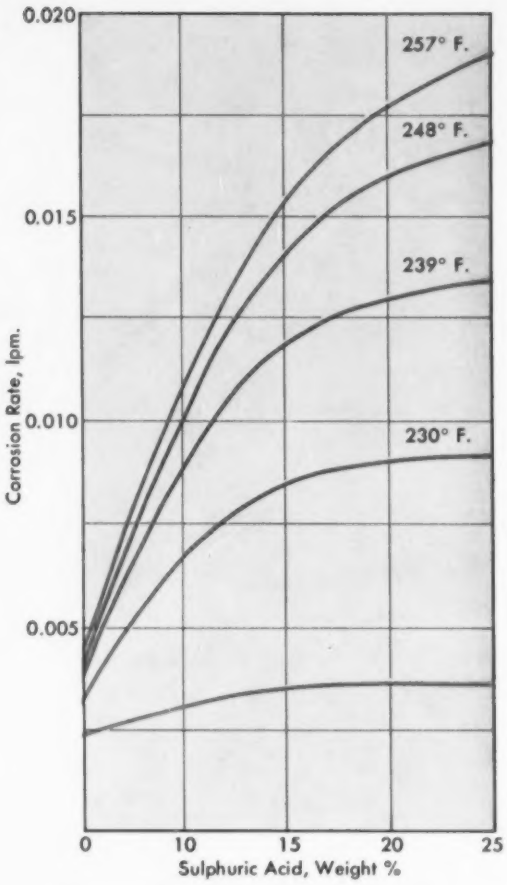


Fig. 4 — Corrosion of Annealed Carpenter No. 20-Cb at Various Metal Temperatures as a Function of Acid Concentration

be converted to inches per month (ipm.) by dividing by 12,000.

Figure 3 illustrates the relationship between metal temperature and corrosion rate at various concentrations of sulphuric acid; these curves are a statistical representation of the data. It is apparent that there is a parabolic relationship between corrosion rate and metal temperature in this concentration range. This is also true of the relationship between acid concentration and corrosion rate at various temperatures (Fig. 4).

Temperature and acid concentration have an additive effect on the corrosion rate; consequently, the usefulness of this alloy in sulphuric acid depends both on acid concentration and metal temperature.

Using the Curves

By means of these curves, designers can control the size of heat exchangers for sulphuric acid. First, they select a corrosion rate which will provide an economical service life. From Fig. 3 they find the maximum metal temperature which will not exceed this rate. Using that temperature as a maximum operating condition, they calculate the heat required to maintain the solution at a given temperature. It is then a simple matter to transmit that amount of heat by a sufficient area to obtain maximum operating conditions. A typical example follows.

Problem: Design an exchanger made of Carpenter No. 20-Cb to heat a 10% (by weight) sulphuric acid pickling solution from 60 to 180° F. and to maintain it at that temperature while in use. Corrosion permitted: about 0.005 in. per month. Total heat required to bring solution up to operating temperature: 2,240,000 Btu. Heat loss at operating temperature (from tank, solution, and work load): 480,000 Btu. per hr.

First, we need the minimum area required to

give a rate of heat transfer equal to the rate of heat loss at the operating temperature. The maximum steam temperature for 10% sulphuric acid is 226° F. For operation at 180° F., the maximum heat flux is 4600 Btu. per hr. per sq. ft.* Dividing the heat transfer required by the maximum heat flux, we have:

$$\frac{480{,}000 \text{ Btu. per hr.}}{4{,}600 \text{ Btu. per hr. per sq.ft.}} = 104 \text{ sq.ft.}$$

Now, how will this area perform in bringing the solution up to operating temperature (180° F.) from 60° F? For this, the maximum flux is 9350 Btu. per hr. per sq. ft.* Multiplying this figure by the minimum area, the heat transfer rate is:

$$9350 \text{ Btu. per hr. per sq.ft.} \times 104 \text{ sq.ft.} = 972{,}400 \text{ Btu. per hr.}$$

*These values are obtained from other curves not included in the article.

Time required for heating is:

$$\frac{2{,}240{,}000 \text{ Btu.}}{972{,}400 \text{ Btu. per hr.}} = 2.3 \text{ hr.}$$

If this time is satisfactory from an operating standpoint, the actual area is equal to the minimum area of 104 sq.ft.

Many variations are possible, of course. A shorter heating time may be required or greater corrosion rates may be permissible. If the cycle is at the operating temperature for extended periods, higher corrosion rates may be allowed during start-up. Through mathematical manipulation of figures from these and other curves, all of these problems can be solved. With the accurate corrosion data obtained with the new test equipment, it is possible to choose the material design and operating conditions for most economical service of any heat transfer surface.

New Techniques for Testing

A Metallograph for the Mill

*By G. H. BOSS**

A portable metallograph, complete with polishing and etching equipment, has been devised for shop use. It is designed for examining heavy machine components on the spot; optical examination at 900 × is possible, and good photomicrographs at 250 × have been obtained. (X4a, X4e)

As ANY METALLOGRAPHER knows, the procedure for photographing a microstructure is fairly complicated. In most laboratories, specimens must be cut, mounted, ground, polished, etched and photographed. Each step is carefully controlled, and work must be done with special equipment under spotless conditions. Now, consider transferring this intricate procedure to a dust-filled shop containing such distractions as overhead cranes, ear-splitting whistles, rumbling trucks and all the other paraphernalia that make the average mill so unsuitable for meticulous work.

That's what we had to do to study the structures of heavy machinery components during various stages of fabrication. Our problem was complicated by the extremely large size and odd shapes of these pieces. To satisfy our require-

*Metallurgist, Aerojet-General Corp., Sacramento, Calif.

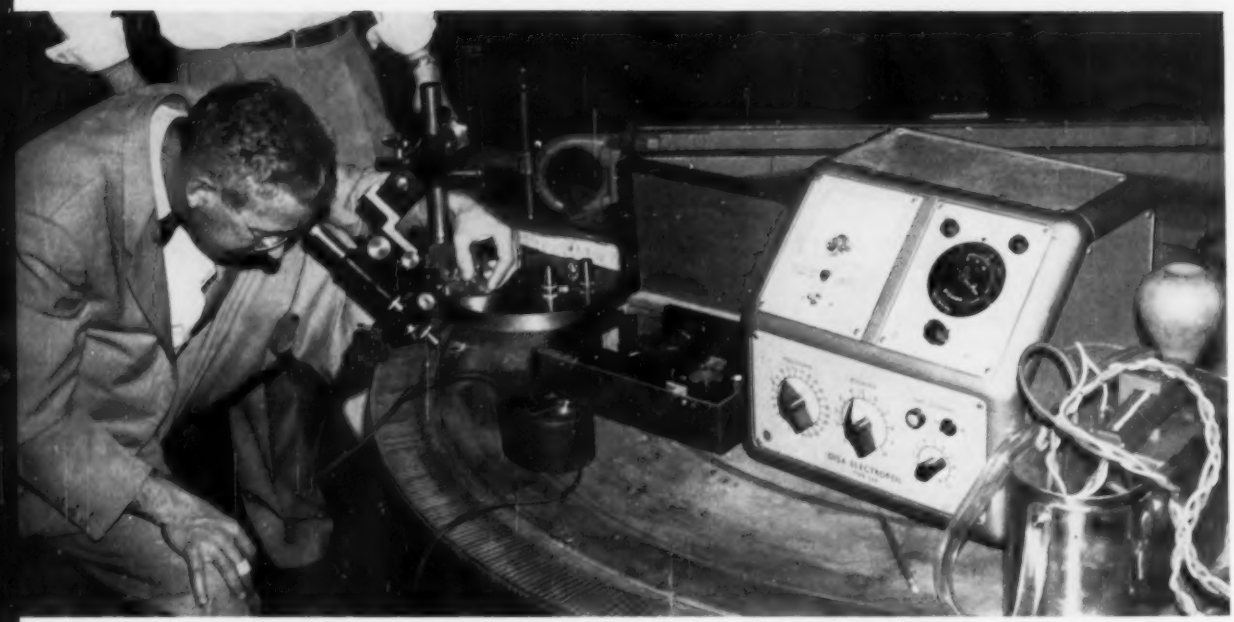


Fig. 1 – Examining the Beveled Edge of a Turbine Bucket Wheel. Portable electropolisher is at right. On flat surfaces such as this, the heavy stand does not require clamping

ments, the equipment had to be easy to carry, yet allow optical examination and photomicrography up to about 1000 ×. Furthermore, grinding and finishing for surface preparation had to be simple enough for use in any well-equipped shop.

Obtaining the equipment for this project was no easy matter. Some of it could be purchased, but we had to design and build several items. Figure 1 shows the optical microscope and the polishing equipment. Use of a portable electrolytic polisher* eliminated the need for an elaborate polishing and etching setup.

Preparation for Viewing

Procedures are much like those used in the laboratory – with some modifications. Before using the electrolytic polisher, mill scale is removed with a fine grinder; the surface is then smoothed with a series of successively finer abrasive cloths down to 600 grit. Grinding wheels and cloths can be attached to air or electric motors, either or both of which are available in all shops. When necessary (so that the electrolytic polisher can function properly), the surface can be finished by hand with the finer polishing papers (0, 00 or 000 grit).

The electrolytic polisher (it operates on 110 v.) completes polishing and etching. This unit consists of one central cabinet, weighing about 40 lb., which contains a direct current rectifier, regulators and timers; instead of the stand and pump for liquid circulation (used for small specimens in the laboratory), a portable gun carries the current and solutions to the specimens when in the shop or field. This gun is light; it is easily manipulated, and can be swung in a 6-ft. radius with the cabinet at the center. The generator is usually adjusted for a complete cycle; this consists of a polishing period (high current density) followed by an etching period (low current density). Current for each period is independently timed and regulated, and during the entire cycle the area (3/8 in. diameter) being prepared is bathed in the polishing and etching solution.

Rigidity Is Important

Probably the biggest problem facing metallographers is vibration; a slight jar can ruin the best photomicrograph. In a laboratory this can be eliminated without much trouble, but in a shop – where the operation of heavy equipment is constant – vibrations are a major concern. It is thus extremely important for the portable microscope to be rigidly attached to the specimen. All joints supporting the microscope should also be rigid.

*Disa Electropol, Uddeholm Co.

Fig. 2 – Photographing With the Portable Metallograph. Steel strapping clamps the metallograph to the round shaft

For this reason, all parts of the microscope stand are extra heavy. The base of the stand is a 12-in. circular plate of stainless steel, 1 in. thick. This plate is clamped to the specimen, and a heavy-duty traversing table is bolted to it. Screws for tilting the table are also provided. A vertical bar, 1½ in. diameter, is welded to the top of the traversing table, and a crosshead placed over this. For a simple setup, the microscope is attached to this head. If a second crosshead is inserted into the first, greater freedom of positioning can be obtained. With the second crosshead, the microscope can be tilted (as shown in Fig. 1) and moved over a wide area.

The microscope, attached to the crossheads by screws, is a single tube with a monocular eyepiece and a turret for objectives. There are two eyepieces (5 and 15 diameters) and three objectives (5, 10 and 60 diameters); if desired, the manufacturer can supply lenses of other magnifications. When the part has been examined and the area to be photographed has been selected, the eyepiece is removed and replaced with the camera shown in Fig. 2. Excellent photomicrographs up to 250 × have been taken with this equipment under shop conditions, and satisfactory examinations by eye have been made at 900 ×, the highest magnification available.

Flow Coat Finishing Today

*By E. A. ZAHN**

It's time to take another look at flow coat finishing, especially if you investigated it in the past and turned it down. Refinements enable the process to handle many finishing operations more efficiently. (L26n)

WITH FEW EXCEPTIONS, any product which can be dipped or sprayed can be finished by the flow coat process. Compared with dip coating, the flow method is based on bringing the paint to the work rather than lowering the work into the paint. The paint is pumped at low pressure and flows through nozzles onto the work as it passes on a conveyer. Surplus paint and that which later drains from the work returns by gravity to the main supply system.

After the primary coat or enamel is applied, parts pass through a solvent vapor chamber, where the vapor concentration is closely controlled. Here, part of the solvent evaporates. Next comes a baking oven to cure the finish. In a two-coat system, flow coating may be used for the primer, and the second coat may be sprayed on, or a second coat may be applied by flow coating using reverse hanging.

The flow coat process at one time enjoyed the limelight of painting methods. That was when it competed only with brushing and dipping. The main advantages then, as now, were economy of application and mechanized finishing. Flow coating has always been almost a 100% paint utilization process. It was the standard method of automobile finishing in the early twenties, but had to be given up in the mid-twenties when lacquers made their debut. At that time lacquers could be applied only with a spray gun and this led to the popularity of the spray method for all manufacturing.

In 1947 a new concept of flow coating appeared. For the first time an installation was devised using the low-pressure principle. Here unshaped, round nozzles were used and paint was applied at pressure of less than 10 psi. (Previously flow coaters used perforated piping with pressures up to 40 psi.) It was found that this machine could handle 1500 different sizes and shapes of parts. This flow coater was highly successful and by the end of 1948 four copies of it were in operation.

In the period 1948 to 1955, flow coat painting grew by leaps and bounds until there were over 6000 installations in the United States and Canada. However, it was in about 1955 that the finishing industry went color mad and not only flow coating but most automatic paint methods took a back seat to job shop painting methods to accommodate the "bleached raspberry chartreuse" colors.

Problem of Colors

At first, color changing in a flow coater did not look easy. There are a few hundred gallons of paint and solvent to consider and a good-sized

*Industrial Finishing Consultant, Louisville, Ky.

piece of equipment to scrub. The problem of color change was thrown at equipment builders who had to find an answer to survive.

Now with new compact equipment this problem has been solved. Color changing in a flow coater has been brought under full control. With fewer nozzles, the paint tanks, pumps and housings can be smaller. Portable paint tanks and power flushing of the smaller housings and drain sections mean 15-min. color changing.

Replacement for Dip Painting

Color or no color, there are still many applications for flow coating. One of these is replacing old, conveyerized mass dipping installations. Compared with dipping, flow coating offers many advantages. Nearly always, dipping requires a large volume of paint. Sometimes the investment in paint is more than the cost of new equipment. Difficulties may arise from air pockets in dipped parts. There is also the problem of part buoyancy. There are no solvent vapor tunnels, as in flow coating, and the film build-up from top to bottom of a dipped piece does present a problem.

With flow coating, generally less than 10% as many gallons are required as in dipping. This often allows use of light-weight equipment, which can be mounted on the roof or mezzanine to save floor space. Flow coat equipment is fully enclosed. Paint is agitated constantly and may be automatically filtered and temperature controlled to maintain a flawless finish.

Use of vapor tunnels, common with low-pressure flow coating but not often found with dipping, has virtually eliminated top-to-bottom gradient in film thickness. Modern flow coat finishing gives less gradient in film thickness than any other paint application method except roller coating, which is confined to flat surfaces.

Adhesion Is Good

In flow coating, the metal surface is so thoroughly wetted that good paint adhesion is assured. Equally significant, paints with high solid content are used. This assists the second most important element in a coating – high film density. Good adhesion and high film density are the two most important factors involved in film performance.

There are no inaccessible areas, regardless of part shape, when flow coating is used. Another attractive feature in dip or flow painting is sealing of overlapped fabrication joints. This applies also to bracket welds.

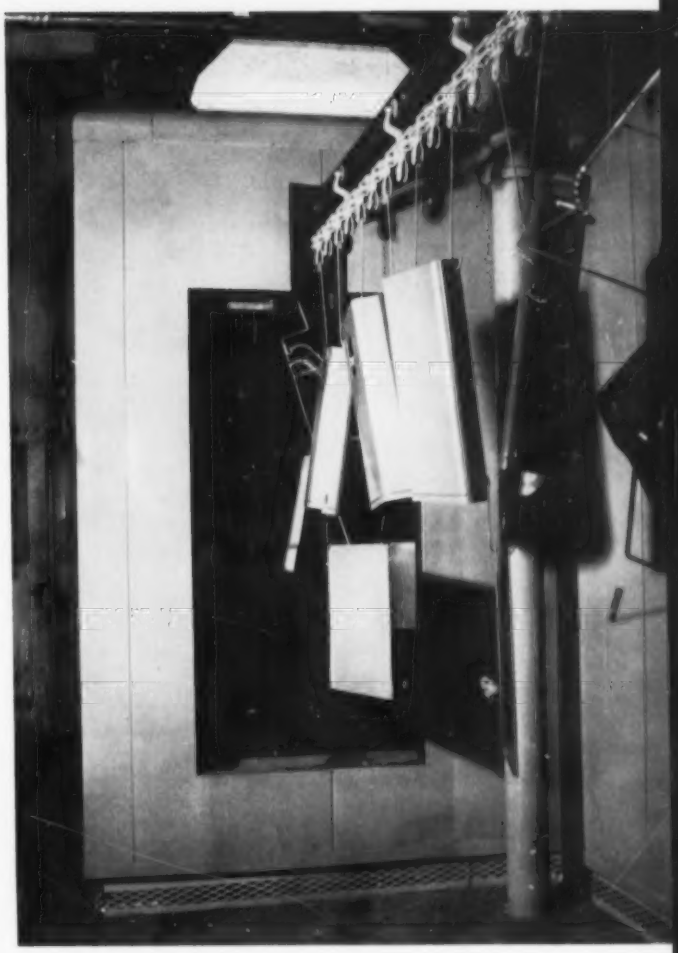


Fig. 1 – Parts in a Variety of Sizes Can Be Coated in a Modern Flow Coater. (Courtesy George Koch Sons Co.)

Variety of Parts Can Be Handled

Early methods for flow coating were limited to relatively small parts. Today there is virtually no limit to part size. A piece 10 ft. long can be flow painted in a vertical position with a gradient in top-to-bottom film thickness no greater than normally found on a piece 12 in. long. This gradient can be as little as 0.0002 in. over a distance of 6 ft.

Parts 20 ft. long are being flow coated in a vertical position hanging from a conveyer. Pieces up to 60 ft. long are flow coated horizontally. One manufacturer paints his entire production of fabricated building trusses with an air drying finish using a small horizontal flow coater. In horizontal flow coating no vapor

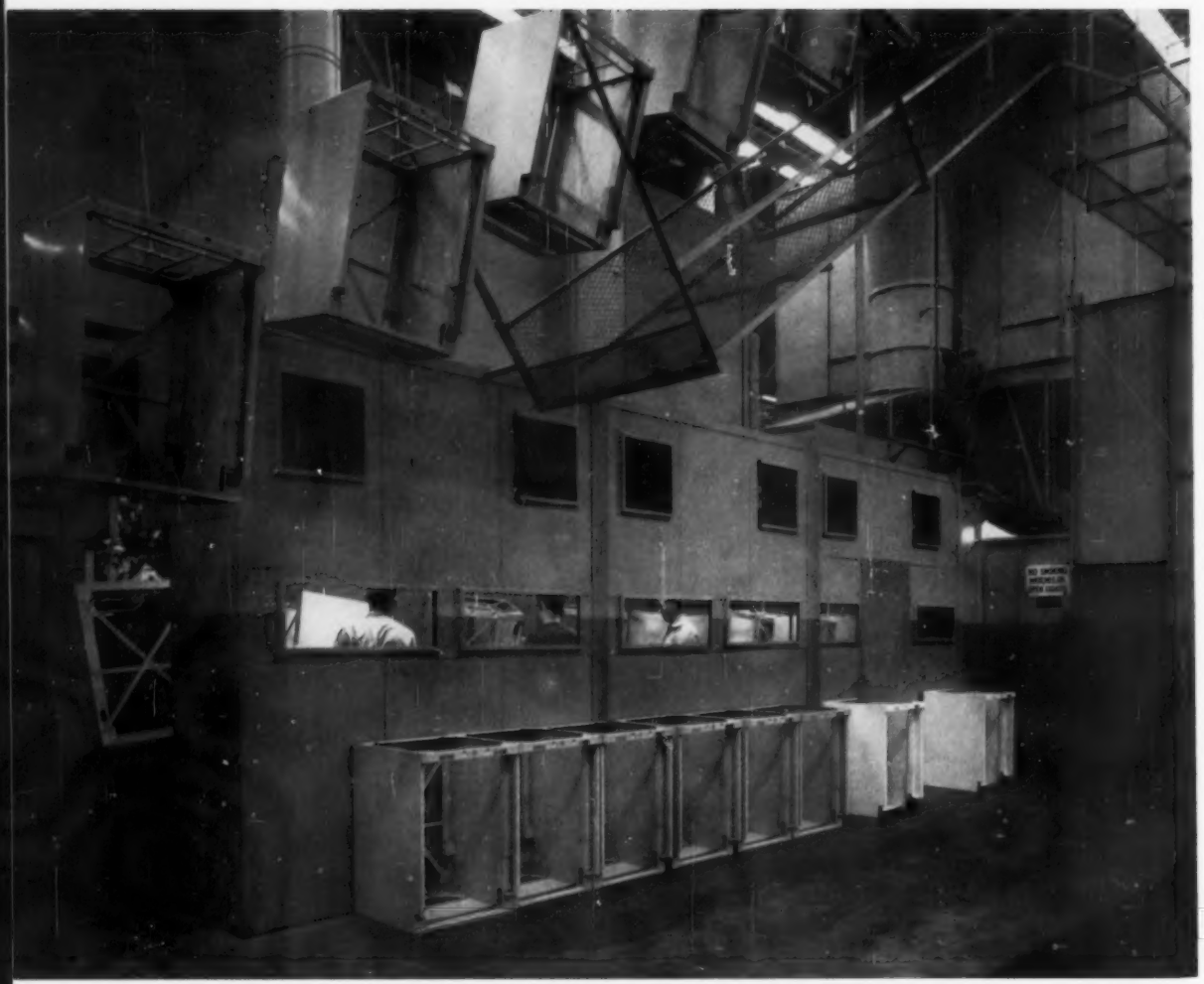


Fig. 2 — In This Plant Flow Coating Is Done in an Overhead Mezzanine and Parts Come Down to Floor Level Where the Finish Coat Is Sprayed on. In other installations, both the first and second coats are applied by flow coating

tunnel is required; surplus paint is wiped from the work by an air stream which is saturated with solvent.

Solvent loss in flow coating is a minimum. Operating equipment using less than 10 gal. of solvent per 8 hr. is not at all unusual. Also, less reducing solvent is needed initially with flow coating compared with other methods of painting.

Some are of the opinion that specific paint formulations are needed for the flow coat process. This is not true. No reformulation of normal paints is required. The paint manufacturer must modify his solvents but this does not constitute reformulation. Solvents which are slightly better are used, but quantity needed is considerably less.

Mechanization Improved Product Uniformity

Until lately, flow coating was thought of as a process for finishing a large volume of parts. Smaller users felt their volume did not warrant the investment in automatic equipment. Quite recently, the process has undergone changes resulting in smaller equipment, fewer nozzles, smaller tanks plus the associated advantages. Any finisher using three drums of paint or more a week can take advantage of the process.

More on Flow Coating ›

Flow Coating Nike Missile Parts

By D. A. HARRINGTON
*and E. A. LEGARE**

A system for automatic processing and flow coating is suitable for finishing large missile fins, yet is flexible enough for numerous small parts. Paint utilization is over 95% and quality of coating is good. This application suggests advantages of the flow coat method for finishing in other industries. (L26n)

FLOW COATING in its simplest form amounts to flooding the part with paint by any number of methods. Excess paint drains off leaving a continuous, nearly uniform coating. Flow coating of missile parts, however, is somewhat more complicated. The decision to use this method for priming missile parts at our Charlotte, N. C., division was made after a thorough evaluation revealed that an automatic system would meet requirements for finishing large missile fins and still be flexible enough for numerous small parts. The size range of typical parts to be finished is shown in Fig. 1.

Our automatic processing and flow coating installation is 540 ft. long from loading to unloading area. The monorail conveyer moves parts through the system at 5 ft. per min. Figure 2 shows the sequence of operations.

At the loading station (Fig. 3), parts are suspended from racks at a minimum pitch of 13° from the horizontal, as near to the center of the line of travel as possible, and at the lowest level that the system will accommodate so pieces will drain to a corner or to a minimum bottom edge area. Racks are lowered from the monorail to floor level to assist in loading.

First Station Cleans Parts

The loaded rack is raised, then pushed forward manually from the loading area until engaged by the moving conveyer which carries it to the first processing station. Here the parts are treated in an alkaline cleaning solution (2 oz. per gal.) at 180° F. (A proprietary cleaner, Oakite 161, is used.) The cleaning solution is pumped under a pressure of 20 psi. from a 2500-gal. holding tank through nozzles located in a rectangular pattern around the cleaning area. Parts are sprayed with cleaning solution for 1.7 min. Drains return the solution to the holding tank to be recirculated. The solution is adjusted daily and analyzed weekly to maintain the proper concentration.

Next comes a hot water rinse to remove all traces of cleaning solution before the chemical conversion treatment. Rinsing requires 1 min. with 120° F. water. Rinse water nozzles are spaced the same as for cleaning and are operated at 15 psi. High nozzle pressures increase the scrubbing action of the cleaner and rinse.

Rinse water is recirculated from a 1200-gal. holding tank, except for the last bank of nozzles which are connected to the plant water line. This gives a fresh water rinse as parts move out of the area. This water drains back into the holding tank insuring a continuous overflow.

Conversion Treatment

Chemical treatment to give a conversion coating takes only 1 min. This coating (Iridite 14-2) provides a good paint base and leaves a corrosion preventive film on the aluminum parts. The processing solution is maintained at 1½ oz. per gal. with pH of 1.4, and is operated in the range 80 to 100° F. The bath is adjusted daily, the same as for the cleaner. The solution is pumped

*Fabrication superintendent and process engineer, respectively, at the Charlotte Div., Douglas Aircraft Co., Charlotte, N.C.

from a 1000-gal. holding tank under a pressure of 5 psi. and the unused solution recirculated. (This area of the process equipment is constructed of stainless steel to avoid attack by the processing solution. The remainder of the equipment is made of low-carbon steel.)

Parts then pass through the cold water rinse (similar to the cleaning rinse) for 1 min. to remove any excess processing solution before they reach the dry-off area. Here, the nozzle pressure is maintained at 5 psi. Low nozzle pressure is used for chemical processing and the subsequent rinsing to avoid excessive scrubbing.

Parts take 4 min. to pass through the 20-ft. dry-off area which is kept at 160° F. with forced hot air. It takes 8 min. for the conveyer to travel from the dry-off area to the flow coat area. This allows parts to cool down to near room temperature before entering the flow coater vestibule. At this point, parts have been cleaned, rinsed, surface treated and dried, without manual handling.

Fig. 1 – Flexibility of Flow Coating Line Is Illustrated by This Exhibit of the Largest and Smallest Aluminum Parts To Be Finished

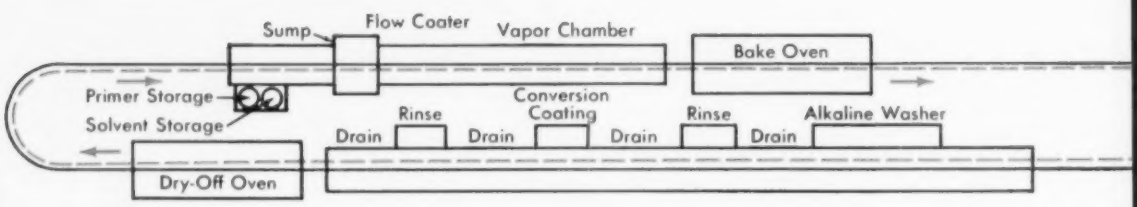


Fig. 2 – Sequence of Operations for Automatic Processing and Flow Coating Nike Parts

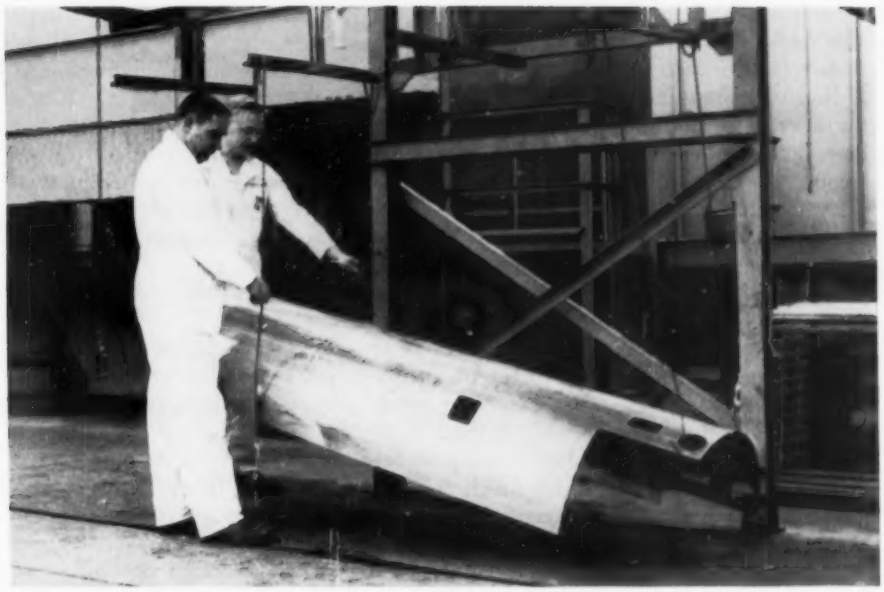


Fig. 3 – Rack Is Lowered to Floor Level to Make It Easier to Load Large Parts. After loading, rack is raised to engage conveyer which carries part to first processing station

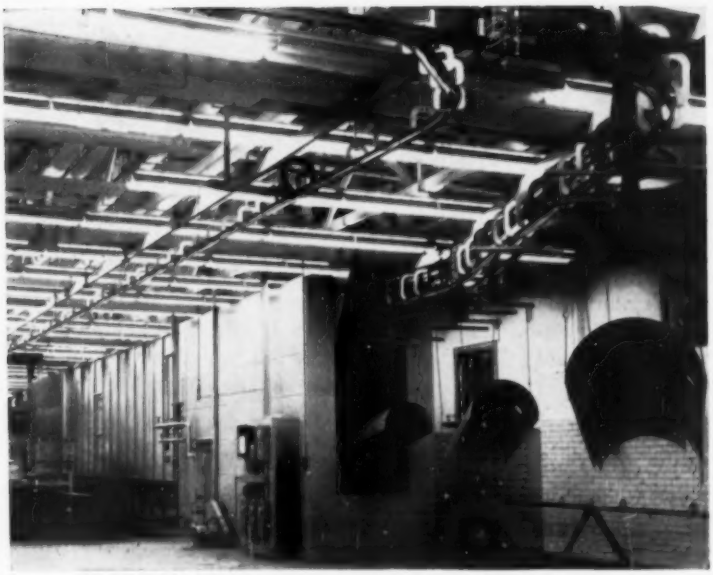
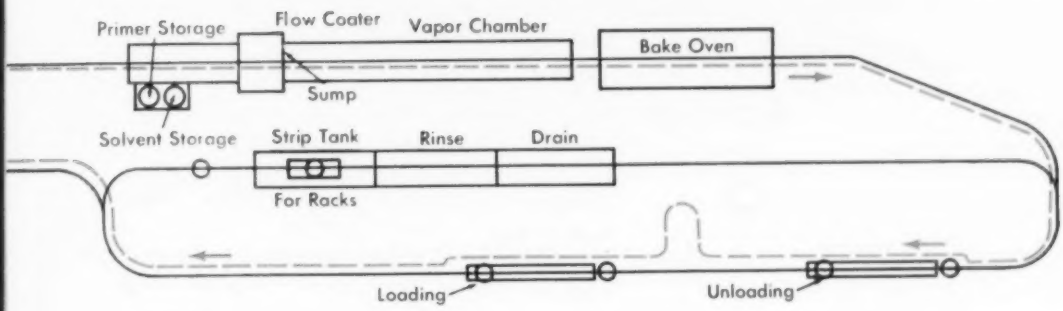


Fig. 4 – Finished Parts Leave Bake Oven Where They Were Heated at 180° F. for 4 Min. Over-all processing time from loading to unloading is about 1½ hr. The equipment was built and installed by Newcomb-Detroit Co.



Parts which are now cool enter the flow coat area where they are flooded with zinc chromate primer (MIL-P-6889 A) for 1 min. The primer is directed on parts from nozzles arranged along the sides and bottom of the flow coater to give most effective coverage. Primer is pumped through the nozzles under a pressure of 3 to 5 psi. The number of nozzles used, their location, and pumping pressure employed must be carefully adjusted for complete coverage of parts.

As the schematic layout in Fig. 2 shows, two flow coating units were installed, but for normal operation only one is used. Nozzle pressure is varied depending on height of part. After parts are covered with primer, they enter the vapor chamber. We feel this is the most critical stage of the entire operation. Here, parts travel through a chamber (35 ft. long) which is filled with solvent vapors to provide controlled drying of the finish. The vapor chamber is maintained at 10 to 15% of the lower explosive limit.

Controlled evaporation of the primer thinner is the key to obtaining uniform thickness of primer over the entire surface of a part. If the thinner evaporates too slowly, the primer coat will be too thin to meet our specification; if it evaporates too rapidly, the coating will be too thick. All parts have a slightly heavier coating at the bottom than at the top, and the coating is slightly thinner under cutouts. Figure 4 shows printed parts emerging from the bake oven.

Control of Coating System

The primer and thinner are each stored in 300-gal. reserve tanks. Some 160 gal. are maintained in the sump, where primer and thinner are mixed. The primer-thinner mixture is kept at a viscosity of 43 sec. (No. 1 Zahn cup), which is about a 1 to 2 primer-thinner ratio. Zinc chromate primer not retained on parts is collected in drains below the flow coater and vapor chamber area. It is pumped through filters back into the coating system.

Thickness of the primer coat is controlled at 0.35 to 0.6 mil (0.00035 to 0.0006 in.) to comply with military and Douglas specifications. A primer coat which is too thin does not give adequate corrosion protection, while a film which is too thick tends to be brittle and causes flaking.

Baking Completes the Operation

Primed parts move from the vapor chamber to the bake oven where they are heated at 180°F. (forced hot air) for 4 min. Here, thinner which remains is vaporized from the primer coating.

Better Finishing

Next month, the editors of *Metal Progress* will present the first in a series of special articles planned to help you do a better job in metal finishing. The purpose of these articles will be to give the best processing practices and present new ideas in finish selection, relating these to product improvement and lower cost.

A 50-ft. staging area allows sufficient time for the parts to cool down and be unloaded. Processing time from loading to unloading requires about 1½ hr.

The flow coater operation is automatic from loading to unloading with the exception of control of solution concentration and adjustment of nozzle pressures, which are manual. A time switch starts all heating and fan systems at a preset time before work begins. This readies the system for operation at the start of the shift. The entire finishing system is operated by a leadman, equipment operator, two men loading and two men unloading.

Proper safety equipment minimizes the dangers associated with this system. Detectors for combustible gas sample the air and vapor mixture in flow coaters and bake ovens. Should the concentration of vapor approach an explosive mixture, an alarm is sounded. Fire extinguishing systems using CO_2 are installed in each paint area and are triggered in event of fire. Simultaneously, all electrical equipment is shut off and an alarm sounds at the fire station. (However, fires are rare with the flow coat process.)

Summary

We feel the following advantages make flow coating attractive both from the economic and quality points of view.

- Considerable savings are made because of more efficient use of primer. Over 95% of the primer is applied to parts; in some finishing systems the utilization figure may be less than 50%.
- Flow coating is a rapid method for painting parts. An average area of 25,000 sq.ft. can be covered each day operating only one shift.
- An automatic system lends itself to more rigid processing controls. This gives a coating of better quality because it is uniform and more continuous.
- The system has the flexibility to handle both large and small parts.

Staff Report

Removing Sulphur and Silicon From Hot Metal

A "rotary reactor" is expected to supplement or replace some of today's steelmaking processes. Hot metal, arriving from a blast furnace, is poured into a rapidly rotating drum, and spreads over the inside wall in a thin layer. Strong alkalis, iron ore and oxygen are added to reduce sulphur and silicon to low values.
(D8n; ST, *S*, *Si*)

THE SEARCH for more efficient ways to increase steel production continues to make news. Diamond Alkali Co. has revealed the details of its "rotary reactor", a device which reduces sulphur and silicon from blast furnace iron to low values. Having progressed beyond the pilot-plant stage, this new development is expected to reduce the refining time needed to make steel.

Further, many savings in steelmaking are anticipated. For example, if sulphur and silicon are removed externally, neither the blast furnace nor openhearth have to take care of them. Consequently, both units will be able to get along with less flux, and the slag blanket will be thinner. The result is more room for iron ore (in the blast furnace) or hot metal (in the openhearth). Because sulphur and silicon are already removed, shorter refining times are possible. Desulphurized hot metal can also be used to advantage in the bessemer converter and electric furnace.

The technique is simplicity itself. Inspection of Fig. 1 (a cutaway view of the machine) reveals the basic concept. Note the rollers at the bottom. They spin the drum rapidly, spreading the incoming hot metal over the inside surface in a thin layer. Since this mechanism offers a large surface area in proportion to the volume of metal in the drum, there is rapid reaction with the agents that are added to remove sulphur and silicon. In the 10 to 20 sec. needed to complete the reactions, hot metal temperature drops in the range of 45 to 75° F. If silicon is also removed, there is no temperature drop. Heat is evolved when silicon combines with oxygen. From the reactor, metal is transferred to an openhearth or electric furnace to be made into steel.

Chemical reactions that take place while the drum is revolving are rather complex. This is especially true when sulphur is being removed. Sodium hydroxide or other strong alkalis added to reduce sulphur react directly with the silicon and sulphur compounds in the hot metal.

For silicon removal, preheated iron ore and oxygen are added with the desulphurizing agent. Unlike the desulphurizing reactions, this reaction is exothermic. Thus, there are two advantages. Not only is silicon removed, but the heat given off keeps the metal at a high temperature.

All of these reactions vary widely in rate, depending on temperature of the metal, sulphur and silicon content of the iron, concentration of Na_2O in the slag, and the amount of siliceous inclusions. However, high efficiencies have been obtained repeatedly. With the pilot reactor that was developed at Battelle Memorial Institute, Columbus, Ohio, iron was consistently desulphurized from 0.11 to below 0.02%, and on occasion, only a trace of sulphur was detected.

A 60-ton per hr. unit operated at the W. O. Larson Foundry at Grafton, Ohio, confirmed the pilot results. Listed below are analyses of samples taken during the test runs:

Cupola Iron	Treated Metal
0.072% sulphur	0.014% sulphur
0.079	0.016
0.075	0.019
0.099	0.013
0.088	0.020
0.083	0.021

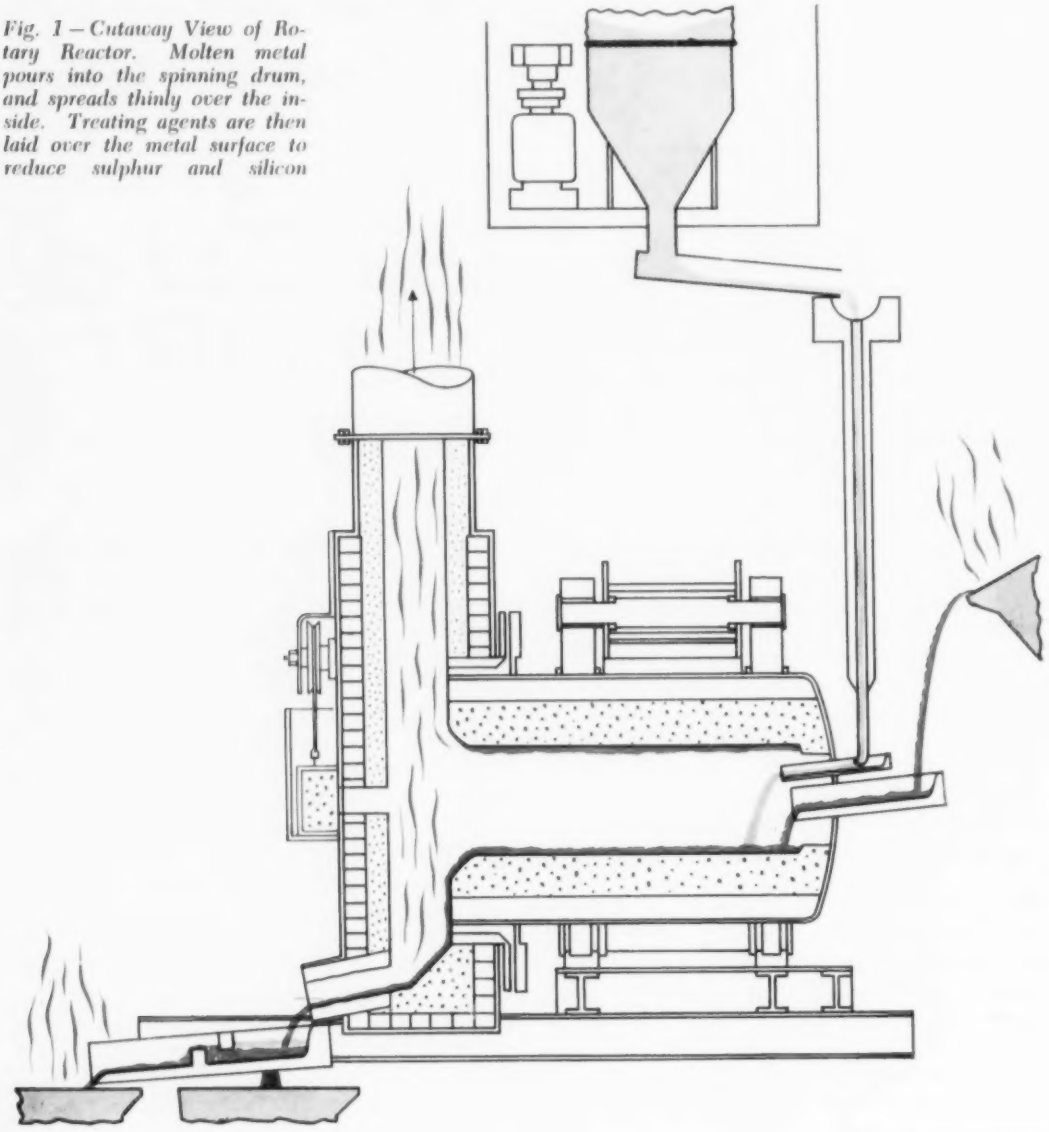


Fig. 1 — Cutaway View of Rotary Reactor. Molten metal pours into the spinning drum, and spreads thinly over the inside. Treating agents are then laid over the metal surface to reduce sulphur and silicon

When desiliconizing, the pilot unit has been able to reduce silicon from 1.27 to 0.40% (69% removal) while carrying out desulphurization. In addition, phosphorus has been reduced as much as 28% during this treatment.

Description of the Equipment

As illustrated in Fig. 2, the reactor consists of three main parts – base, rotor and hood. The base is complete with variable speed drive and drive rollers. The rotor, lined with refractory and supported by rolls at its two tires, is nearly enclosed by protective guards. Although not shown, the rotor has a dam at the inlet end and is open at the discharge end.

of the rotor. The entire machine is easily maintained and dismantled.

Operation of the Equipment

Most of the operational details were worked out during an extensive development program at Battelle, which lasted three years. Scores of tests were made with a pilot reactor, having a rotor 3 ft. long with an inside diameter of 10 in. Various additives, temperature, reaction time and rotational speed were controlled and adjusted to obtain maximum efficiencies.

Here are details of the process as finally worked out. Hot metal flows through the inlet runner and into the revolving rotor. Held to

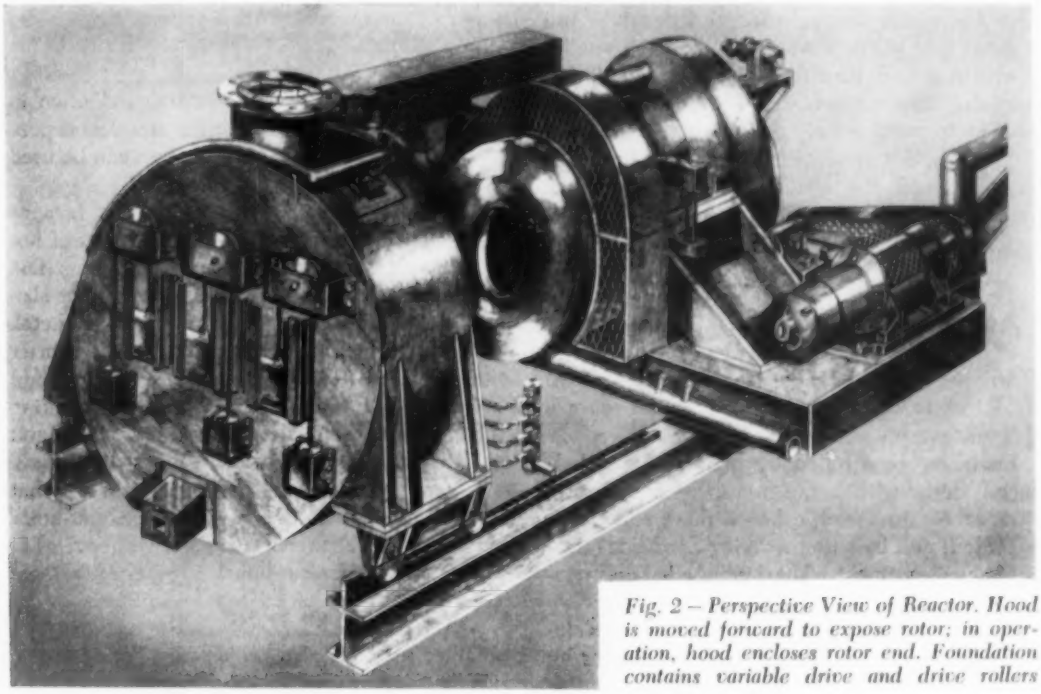


Fig. 2 – Perspective View of Reactor. Hood is moved forward to expose rotor; in operation, hood encloses rotor end. Foundation contains variable drive and drive rollers

When in use, the refractory-lined hood is rolled forward to cover the open end of the rotor. This end is cooled externally both by air and water. At the base of the hood is a discharge runner for hot metal, while an exhaust duct above removes fumes.

Two gas burners preheat the reactor. One is situated in the hood, the other on a pivoting support at the inlet end of the rotor. Additives, which are stored in a hopper above the inlet end, are added at a controlled rate through a water cooled tube extending into the inlet end

the inner wall by centrifugal force, the metal forms a 1 to 2-in. layer covering the entire inner surface.

Pellets of sodium hydroxide or other strong alkalis are then added so that they overlie the surface of the molten metal. (Preheated iron ore and oxygen are also added here to remove silicon.) As the material builds up a head against the dam at the inlet end, a turbulent, helical flow takes place toward the discharge end. Thus, there are four conditions causing intimate contact between molten metal and treating agent.

These are: (*a*) keeping a thin layer of metal (large surface area) during reaction, (*b*) turbulent action resulting from flow of metal through the spinning rotor, (*c*) additives of small particle size or in gaseous form, and (*d*) centrifugal force causing intimate contact between the treating material and the molten metal.

Treated metal and slag leaving the rotor are collected in the hood; they flow continuously out through the discharge runner. Slag can be separated by damming and skimming the flow in this runner.

Several factors influence efficiency. For instance, reactors are designed to retain hot metal in the rotor for 10 to 20 sec. Diameter and rpm. of the rotor are the important factors since they determine the centrifugal force. Figure 3 shows that 180 rpm. was needed for the smaller diameter pilot reactor to attain 95% reduction in sulphur. The rotor in the 60-ton per hr. unit needed to revolve only 135 rpm. to reach the same reduction rate. This rotor was larger in diameter and the optimum centrifugal force could be reached with a lower speed.

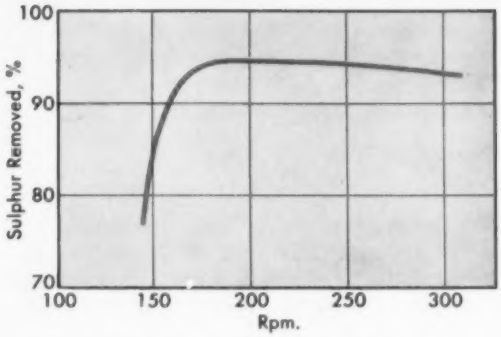


Fig. 3 – Sulphur Removal as a Function of Rotor Speed. A speed of 180 rpm. was required to attain optimum centrifugal force in the experimental reactor (10 tons per hr.) operated at Battelle Memorial Institute. The larger diameter rotor in the 60-ton per hr. unit needed only 135 rpm.

Features of the Equipment

Temperature losses are reduced by operating within a closed or balanced draft system. After the 60-ton per hr. reactor had reached thermal equilibrium, metal temperature dropped 45 to 75° F. while desulphurizing. If operations are intermittent, preheating is required.

Fumes are controlled by maintaining a balanced draft within the reactor. A butterfly damper in the hood exhaust duct eliminated hazardous and irritating working conditions during heavy treatment when highly alkaline materials were used.

Strong alkaline treating agents attack refractory linings. This is prevented in the reactor by the protective layer of metal on the inner rotor wall. The additive does not come in contact with the refractory. As a consequence, the lining in the smaller unit endured scores of heats. It was not affected by thermal shock or chemical attack, though there was some erosion at the metal inlet. Similar results were obtained with the larger unit.

Applications for the Equipment

Those acquainted with steel production can envision many areas in which this reactor can be used. As mentioned before, it can be used to treat metal from the blast furnace. Furnace capacity can be increased through reduction in limestone and coke burden. Further, less expensive coke, containing higher sulphur, can be used as well as ores with higher silicon.

Operators of openhearth or electric furnace equipment can appreciate the advantages of hot metal with low sulphur and silicon. Less flux is needed; this in turn, results in a thinner slag blanket, and there is more room for molten metal. Coupled with these larger heats are the shorter times needed to "work the heat". Sulphur and silicon are already at acceptable levels; working time can be devoted to lowering carbon and phosphorus content.

Larger heats in shorter times – this is what a melter needs to increase his tons-per-hour. Furthermore, management's good humor rises in proportion to tons-per-hour.

Future Applications

Other uses are also projected. For instance, bessemer converters do not remove sulphur from hot metal. If sulphur is first removed in a reactor, converters may be able to produce an improved steel. Electric furnaces do not handle conventional hot metal too well. The large volumes of slag required reduce capacity. Use of desiliconized wash metal (0.40% Si, 3.5% C) instead of the standard cold metal charge will increase furnace capacity.

Plans call for reactors that reduce carbon and phosphorus as well; when that day comes we may see reactor plants that produce steel, of fender stock quality, directly from the blast furnace iron.

Welding Electrode With Built-In Kinks

*By THOMAS W. SHEARER**

This corrugated electrode compensates for wide trim tolerances by depositing an extra wide weld bead that straddles the seam. (W29h; 4-61)

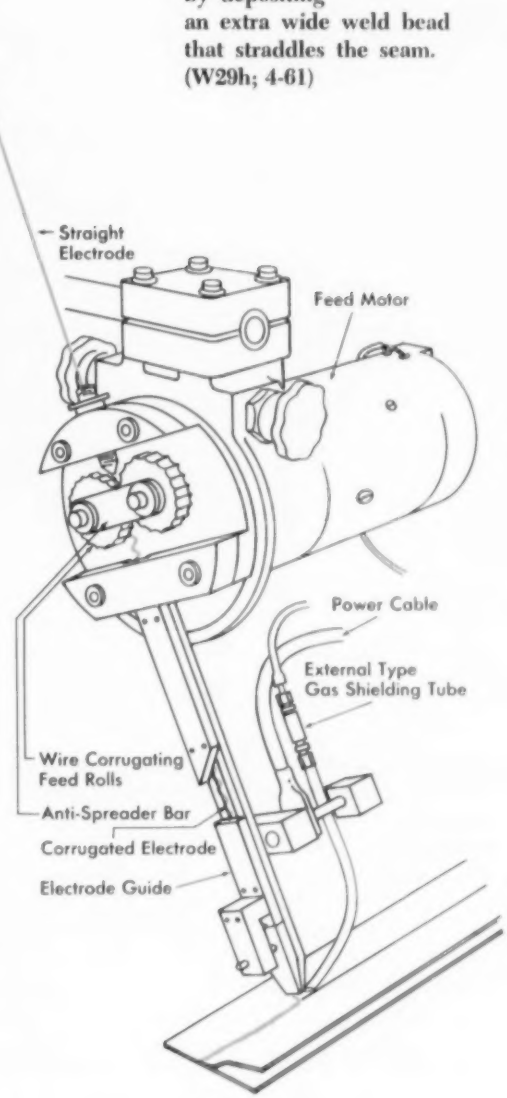
THE PROBLEM of compensating for wide trim tolerances in weld butt and lap joints prompted the development of our corrugated wire welding electrode. It compensates for trim variances by producing a wide weld bead that straddles the seam.

Preliminary tests involved a mechanical, air-powered vibrating device that produced an oscillating arc. Although this was successful, the idea occurred to simplify the oscillating mechanism by mechanically corrugating the wire.

Corrugating is done with meshing, gear-shaped drive rolls. The wire electrode enters the drive rolls straight; here the gears form kinks in the wire and it emerges corrugated as shown in the drawing. The corrugated electrode is fed through a current pickup device. The arc is drawn from the end of the corrugated electrode, and, as the electrode burns off, the arc oscillates back and forth between the limits of the width of the corrugation. The weaving action of the oscillating arc compensates for misalignment and wide trim tolerances.

The corrugated electrode will operate on either the constant current or constant potential type of power supply. Both corrugating feed rolls are powered by a General Electric wire feed motor. Gas shielding, provided externally, uses either inert gas or CO_2.

The lap weld illustrated in the drawing represents a seat frame made from 0.047-gage cold rolled 1020 steel. CO_2 gas flow is maintained at 10 cu.ft. per hr; carriage speed is 80 in. per min., and machine settings are 22 v. and 140 amp. Commercial welding wire for use with inert gas has a diameter of 0.045 in.



Feeding Mechanism for Corrugating Conventional Welding Electrode Wire

*Group Engineer, Fisher Body Div., General Motors Corp. Detroit.

Etching Reagents for Dislocations in Metal Crystals

*By L. C. LOVELL, F. L. VOGEL and J. H. WERNICK**

General methods and precautions. Data sheet on p. 96-B lists recommended etching solutions and times for various metals, and shows some typical results. (M20q, M26b)

ETCHING METHODS for revealing dislocations in crystals have not been fully exploited either in the classroom laboratory, where they offer unparalleled opportunities to teach the phenomena of dislocations, or in the research laboratory, where they can yield information which only a few years ago was unobtainable.

Surfaces for etching are customarily prepared by polishing, either mechanically or electrolytically (unless the etching solution leaves a smooth polished surface). Examination in a light microscope at moderate magnifications is usually adequate, although occasionally electron microscopy has advantages.

Sometimes it is necessary to "decorate" the dislocations to produce satisfactory results. For this, small amounts of favorable impurities are incorporated into the crystal. An annealing and aging treatment will then diffuse these impurities to the dislocations where they will remain on cooling. The concentration of these foreign atoms at the dislocation produces (in the presence of the appropriate reagent) isolated chemical action, and a pit forms.

Method of Preparation

Probably the greatest problem confronting the dislocation etch pit experimenter is that of reliability, since not all etch pits are dislocations, and, conversely, not all dislocations etch as pits.

As with conventional metallography, a smooth flat surface is needed. This is obtained by grinding on successively finer abrasives; polishing — either mechanical, chemical or electrolytic — completes the work. Where the dislocation etch is sensitive only to a given crystal face, the first grinding step must be done in a goniometer or similar device to determine the orientation of the surface eventually to be viewed. In some brittle crystals, a suitable viewing surface is easily made by cleavage. This also has the unique advantage of producing two faces which are identical and mirror images of each other.

Those precautions, which are necessary to produce superior results in conventional metallography, also apply here. Freshly made solutions generally bring the best results, and careful control of time and temperature is sometimes necessary. Except when stated otherwise, the common acids are concentrated and of reagent grade. The hydrofluoric acid is a 48 to 51% aqueous solution, and superoxol (H_2O_2) a 29 to 31% solution. In general, distilled water is used for preparing solutions and rinsing specimens.

The data sheet on p. 96-B lists recommended etching solutions and times for various metals. Figures 1 through 3 show some typical results.

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96-A

Etching Reagents for Dislocations

Compiled by L. C. Lovell, F. L. Vogel and J. H. Wernick, Bell Telephone Laboratories, Inc.

References

1. "Slip Lines and Etchpits", by S. Amelinckx. *Philosophical Magazine*, Vol. 44, No. 356, Sept. 1953, p. 1048 to 1049.

2. "Direct Observations of the Arrangement and Motion of Dislocations in Aluminum", by P. B. Hirsch, R. W. Horne and M. J. Whelan. *Philosophical Magazine*, Vol. 1, No. 7, July 1956, p. 677 to 684.

3. "Dislocation Etch Pits in Antimony", by J. H. Wernick, J. N. Hobstetter, L. C. Lovell and D. Dorsi. *Journal of Applied Physics*, Vol. 29, 1958, p. 1013.

4. "The Presence of Preferred Micro-Domains of Attack in a Copper-Zinc Polycrystalline Solid Solution Very Slightly Deformed by Tension", by Pierre A. Jacquet. *Comptes Rendus*, Vol. 237, No. 20, Nov. 16, 1953, p. 1248 to 1250.

5. "Observations on Etch Pits and Sub-Boundaries in Columbium", by A. B. Michael and F. J. Huegel. *Acta Metallurgica*, Vol. 5, 1957, p. 339 to 341.

6. "Partial Polygonization in Impure Copper Crystals", by F. W. Young, Jr., and N. Canbrera. *Journal of Applied Physics*, Vol. 28, 1957, p. 339 to 791.

7. "Dislocation Etch Pits and Polygonization in High-Purity Copper", by L. C. Lovell and J. H. Wernick. *Journal of Applied Physics* (in press, April 1959).

8. "Observations of Dislocations in Lineage Boundaries in Germanium", by F. L. Vogel, W. G. Pfann, H. E. Corey and E. E. Thomas. *Physical Review*, Vol. 90, May 1, 1953, p. 489 to 490.

9. "Some Defects in Crystals Grown From the Melt. I. Defects Caused by Thermal Stresses", by E. Billig. *Royal Society, Proceedings*, Vol. 235, Ser. A, Apr. 10, 1956, p. 37 to 55.

10. "Dislocations at Compositional Fluctuations in Germanium-Silicon Alloys", by A. J. Goss, K. E. Benson and W. G. Pfann. *Acta Metallurgica*, Vol. 4, May 1956, p. 332 to 333.

11. "Persistence of Networks of Impurities and Imperfections in a Pure Iron After Various Heat Treatments", by Pierre Coulomb. *Comptes Rendus*, Vol. 245, Aug. 12, 1957, p. 799 to 802.

12. "Observation of Dislocation Sites in Iron", by F. W. C. Boswell. *Metal Progress*, Vol. 72, Dec. 1957, p. 92 to 93.

13. "Etching Reagents for the Microscopic Examination of Iron and Steel", *Metals Handbook*, 1948, p. 396.

14. "Investigation of Pure Iron and Soft Steel With the Electron Microscope", by F. Van Wijk and J. A. B. Van Dijck. *Acta Metallurgica*, Vol. 4, 1956, p. 657 to 659.

15. "Sub-Structure in Ferrite", by P. Samuel and A. G. Quarrell. *Iron and Steel Institute, Journal*, Vol. 182, Jan. 1956, p. 20 to 30.

16. "A Study of (112) Edge Dislocations in Bent Silicon-Iron Single Crystals", by W. R. Hibbard, Jr., and C. G. Dunn. *Acta Metallurgica*, Vol. 4, 1956, p. 306 to 315; "Electropolishing of Steel in Chrome-Acetic Acid Electrolyte", by C. E. Morris. *Metal Progress*, Vol. 56, Nov. 1949, p. 696 to 699.

17. "Electron Microscopic Study on the Structure of Mosaic Boundaries in Ni-Mn Single Crystal", by Tadami Taoka and Shoichiro Aoyagi. *Physical Society of Japan, Journal*, Vol. 11, No. 5, May 1956, p. 522 to 527.

18. "Copper Precipitation on Dislocations in Silica", by W. C. Dash. *Journal of Applied Physics*, Vol. 27, 1956, p. 1193 to 1195.

19. Paper by J. W. Faust, Jr., Abstract No. 90, Electrochemical Society *Bulletin*, May 1955.

20. "Dislocation Etch Pits in Silicon Crystals", by F. L. Vogel, Jr., and Clarence Lovell. *Journal of Applied Physics*, Vol. 27, Dec. 1956, p. 1413 to 1415.

21. "Preferential Etch for Use in Optical Determination of Germanium Crystal Orientation", by R. H. Wynne and Colman Goldberg. *Journal of Metals*, Vol. 5, Mar. 1953; *Transactions of American Institute of Mining and Metallurgical Engineers*, Vol. 197, 1953, p. 436.

22. "Dislocation Configurations and Densities in Tantalum Crystals", by R. Bakish. *Acta Metallurgica*, Vol. 6, 1958, p. 120 to 122.

23. "Dislocation Etch Pits in Tellurium", by L. C. Lovell, J. H. Wernick and K. E. Benson. *Acta Metallurgica*, Vol. 6, 1958, p. 716.

24. "Etch Pits and Dislocations in Zinc Monocrystals", by J. J. Gilman, *Journal of Metals*, Vol. 8, 1958, p. 998.

Etching Reagents for Dislocations

Material	Etch Solution and Time	Plane*	Remarks†
Aluminum (99.99%)	50% HCl, 47% HNO_3, 3% HF.	—	—— (1)
Aluminum (impure)	Dilute HF.	—	After decoration in vacuo at 660° F. (2) Cleaved surface. (3)
Antimony‡	CP-4§; 2-3 sec.	(111)	
Antimony‡	1 part HF, 1 part Superoxol, 4 parts H_2O; 1 sec.	(111)	—— (3)
Bismuth	1% I_2 in Methanol; 15 sec.	(111)	Cleaved surface.
Brass (65% Cu, 35% Zn)	0.2% $Na_2S_2O_4$‡; 60 sec.	—	Current density, 0.6 amp. per sq.in. Remove film with HCl [65 to 68° F.] (4)
Columbium	10 cc. H_2O, 10 cc. H_2SO_4, 10 cc. HF, few drops Superoxol.	—	Agitate specimen in solution. (5)
Copper (impure)	60% H_3PO_4 in H_2O‡; 10 sec.	(112)	Decorate by annealing at 930° F. for several hours before etching. (6)
Copper (pure)	4 parts sat. $FeCl_3$ solution, 4 parts HCl, 1 part acetic acid plus few drops Br_2.	(111)	Rinse in NH_4OH. (7)
Germanium (Also 0.2 at. % B; 6.0 at. % Si; 0.2 at. % Sn)	CP-4§; 3 to 5 sec.	(100) (111)	Polish etch. 600-grit Carborundum ground surface. (8, 10)
Germanium	8 g. $K_3Fe(CN)_6$, 12 g. KOH, 100 cc. H_2O; 2 to 5 min.	(100)	600-grit Carborundum ground surface [boiling]. (9)
Iron (99.96%)	4% metanitrobenzo-sulphonic acid in Ethanol; long etch.	—	Rinse in Ethanol. Result questionable. (11)
Iron	Step 1 – 1% HNO_3 in Ethanol; 1 min. Step 2 – Rinse in Methanol. Step 3 – 0.5% picric acid in Methanol; 5 min.	—	Caution – Reagent unstable! Pits appear only in specimens cooled slowly from 1400 to 1550° F. (12)
Iron	Fry's reagent; 10 sec.	—	Chemically polished surface. (13)
Iron (99.99%)	Disa Electropol ‡ solution A-2.	—	Observation by electron microscopy. (13)
Iron	2% Nital containing 2% saturated picral; 15 min.	—	—— (14)
Iron	Saturated picral; 4 min.	—	Anneal at 1750° F. to decorate dislocations. (15)
Iron-silicon (3.25% Si)	133 ml. acetic acid‡, 25 g. CrO_3, 7 ml. H_2O; 5 to 20 min.	—	C.d. = 0.18 amp. per sq.in. Decorate with 0.004% carbon at 1420° F. or above in low-pressure acetylene atmosphere [63 to 66° F.]. (16)
Nickel-manganese	100 cc. H_2PO_4‡, 100 cc. Ethanol; 2 min.	(110)	C.d. = 13 amp. per sq.in. Copper cathode [105° F.]. (17)
Silicon	1 part HF, 3 parts HNO_3, 12 parts acetic acid; 15 min. or longer.	(111) (100) (110)	Chemically polished surface. (18)
Silicon	4 parts HF, 2 parts HNO_3, 4 parts 3% aqueous $Hg(NO_3)_2$.	(100) (111)	600-grit Carborundum ground surface. (19)
Silicon	3 parts HF, 5 parts HNO_3, 3 parts acetic acid, 1.5-2 parts 3% aqueous $Hg(NO_3)_2$; 2 min.	(100) (111) (110)	600-grit Carborundum ground surface. Use deionized H_2O. Utensils and specimen must be dry. (20)
Silicon	160 cc. HF, 80 cc. HNO_3, 160 cc. H_2O containing 8 g. $AgNO_3$.	(100) (111)	600-grit Carborundum ground surface. (21)
Tantalum	5 parts H_2SO_4, 2 parts HNO_3, 2 parts HF.	(112)	Decorate by oxidizing 30 min. in air at 1400° F. Degas in vacuo 30 to 40 min. at 3450° F. (22)
Tellurium	3 parts HF, 5 parts HNO_3, 6 parts acetic acid; 1 min.	(1010)	Cleaved surface. (23)
Zinc	160 g. CrO_3, 60 sec.; 50 g. Na_2SO_4-10 H_2O, 500 cc. H_2O, 1 min.		Mild agitation. Yellow-brown chromate film removed by dip in 160 g. CrO_3 in 500 cc. H_2O. Decorate specimen with 0.1 at. % Cd. Anneal at 570-750° F. Age 1 week at room temperature. (24)

*Dislocations appear on these crystallographic planes. Crystals should be ground (or cleaved) accordingly.
†All etching at room temperature unless otherwise indicated in brackets. Numbers in parentheses indicate references.
‡Electrolytic etch.
§3 parts HF, 5 parts HNO_3, 3 parts H_3COOH, 3 drops liquid Br_2.

Fig. 1 – Antimony Etched in CP-4 (111), 900 ×

Fig. 1 – Antimony Etched in CP-4 (111). 900 ×

Fig. 2 – Antimony Etched in Superoxol (111). 250 ×

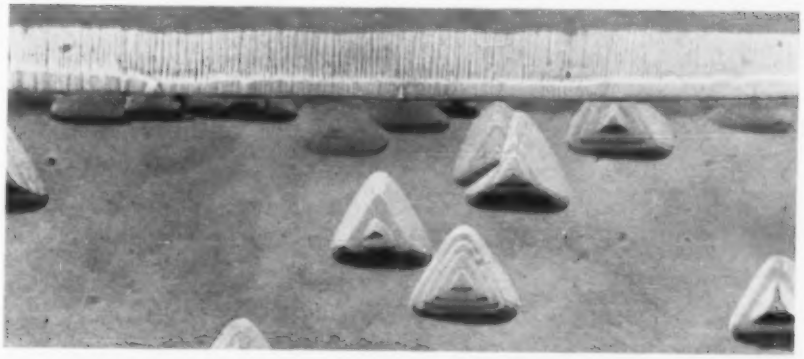


Fig. 3 – Polygonized Bismuth (111). 225 ×

Fig. 4 – Germanium (100). 750 ×

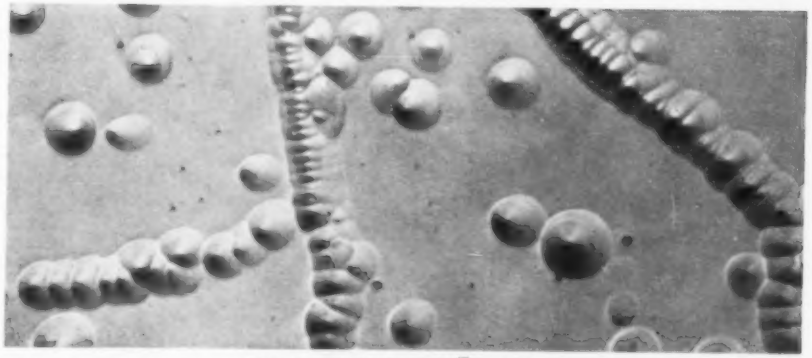


Fig. 5 – Silicon (100). 2000 ×

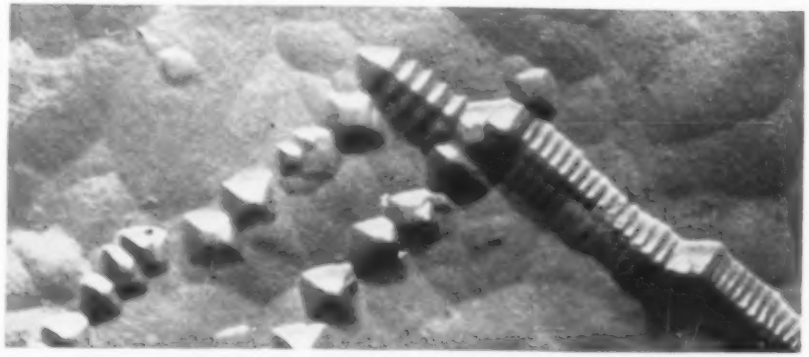
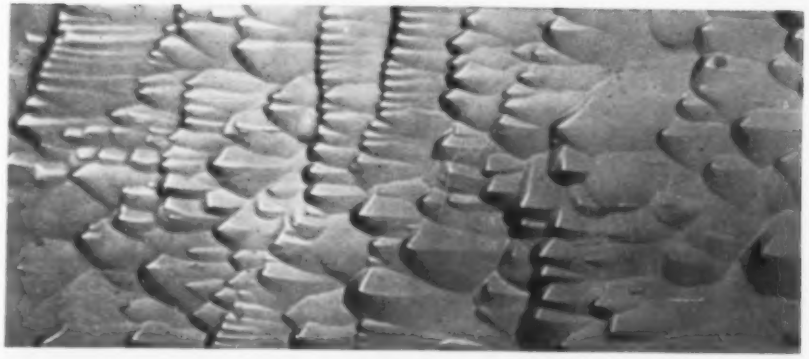


Fig. 6 – Tellurium ($10\bar{1}0$). 850 ×



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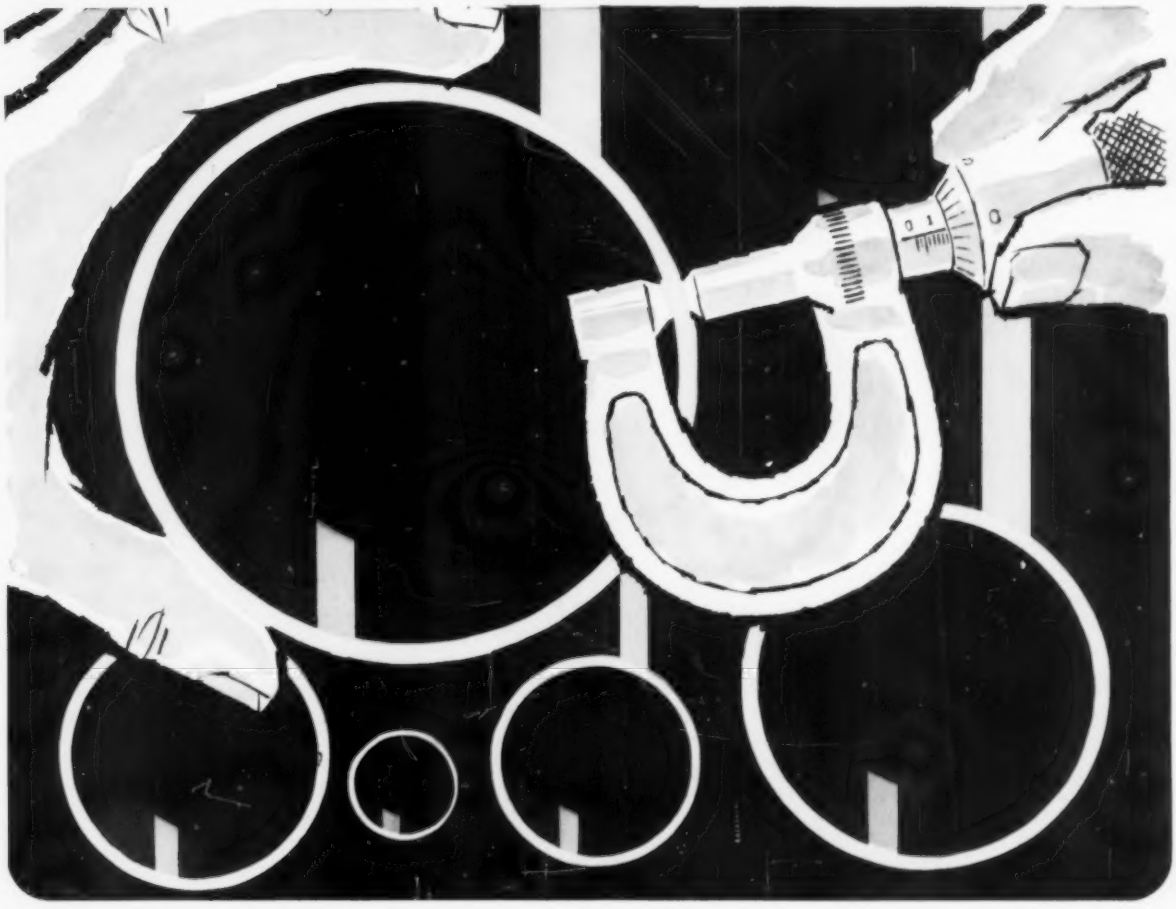

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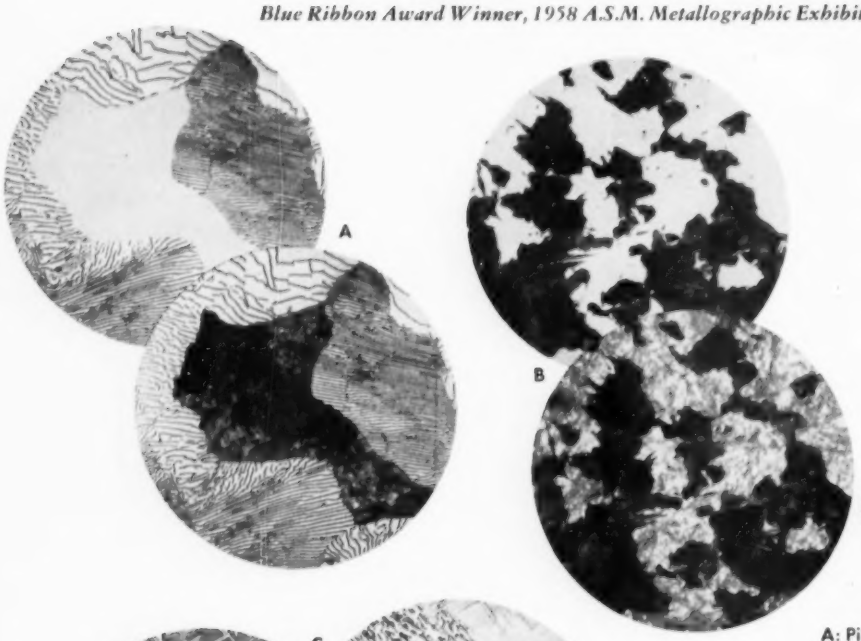

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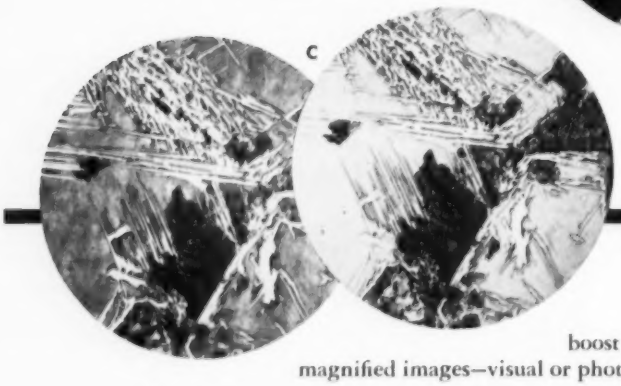

A: Picral Etch—Sodium Bisulphite Etch

B: Picral Etch—Sodium Bisulphite Etch

C: Picral Etch—Picral and Sodium Bisulphite

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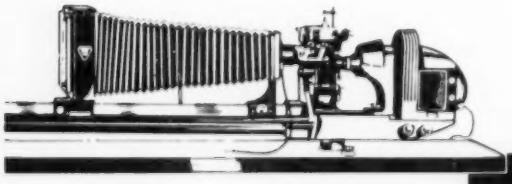

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Metals for the Atomic Boiler

*By B. LUSTMAN**

Water at 530° F. and 200 psi. is highly corrosive, even when alkalinized and carrying hydrogen in solution. The Shippingport reactor vessel is lined with Type 304 stainless steel, and all piping and heat exchanger tubing are made of the same alloy. (T11, 17-57; SS, Zr-b)

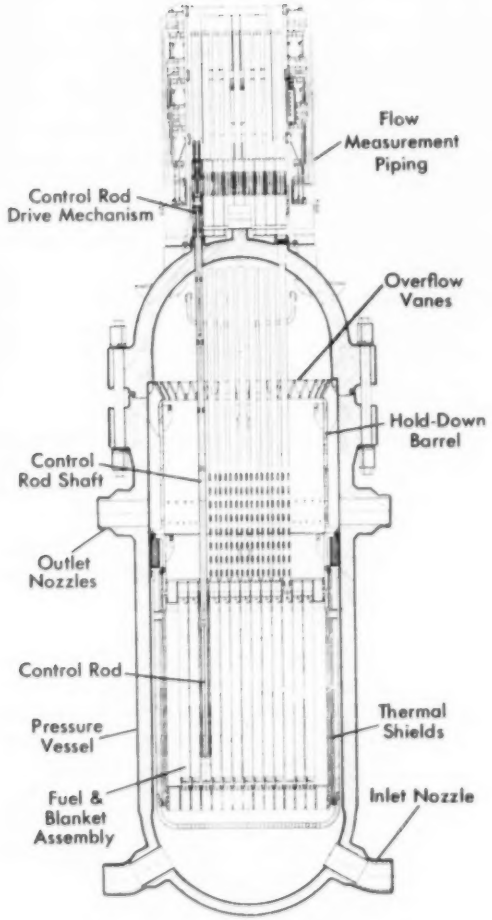


Fig. 1—General Drawing (Vertical Cross Section) of PWR Pressure Vessel

START of the Shippingport nuclear power plant in December 1957 put "on line" the first American plant of full scale designed exclusively for generating industrial power. Its operation, therefore, will provide information about many important problems other than to prove the design and construction†, such as the integration of a nuclear power plant into a conventional public utility (Duquesne Light Co.), the adequacy – or real necessity for – the many safeguards for personnel and surrounding areas, and the operating costs. It will also advance the technology of the pressurized water reactor concept (PWR), a reactor simultaneously moderated and cooled with light water under high pressure. The coolant is ordinary water, demineralized of impurities (which became radioactive during neutron bombardment) and having 25 cc. of gaseous hydrogen in solution per liter to reduce its corrosive effect on the metals it comes in contact with, and a pH of 9.5 to 10.5 maintained with LiOH to diminish the deposition on heat transfer surfaces of insoluble particles which are entrained. As was shown in a previous article entitled "Fuel for the Atomic Engine", *Metal Progress*, April 1958, p. 72, the heat comes from a chain reaction established by highly enriched uranium dioxide. The uranium oxide is protected from contact with the water by sheathing in Zircaloy-2.

*Manager, Metallurgy Subdivision (Pressurized Water Reactors), Atomic Power Div., Westinghouse Electric Corp., Bettis Field, Pittsburgh.

†While Westinghouse Electric Corp. was principal contractor to the Atomic Energy Commission on this project, literally hundreds of American firms were subcontractors.

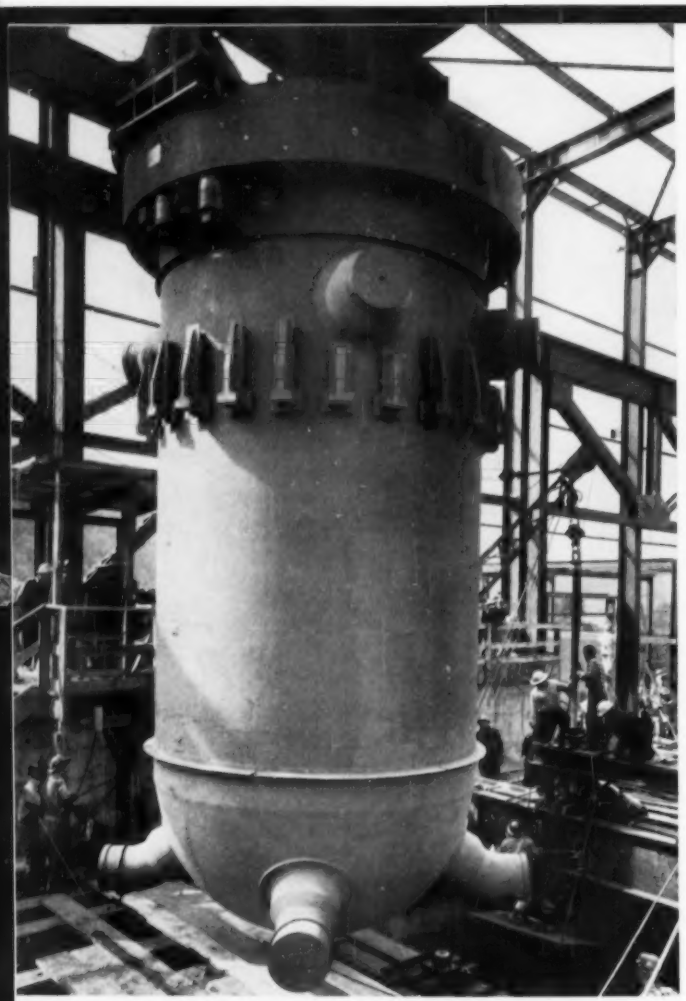


Fig. 2 – Reactor Pressure Vessel Being Lowered Into Position at Shippingport

The three principal portions of the PWR plant are the reactor, the coolant loop, and the generating station.

The reactor portion includes the reactor vessel and those components housed within it, such as the nuclear core (or enriched seed and natural uranium blanket), the control rod assembly, and the required instrumentation and supporting structure. A cross section of the reactor vessel is shown in Fig. 1. A better idea is given by Fig. 2. It is a cylinder 31 ft. high, 9 ft. diameter, and 8 in. thick, lined with ¼-in. stainless steel. The weight in operating order is about 250 tons. This vessel is the largest of its kind ever constructed for this combination of temperature and pressure; consequently, its size and the designed reactor output were to a large extent determined by the thickness of plate and forgings which the pressure vessel industry could handle at the time the plant was being designed.

The assembly of nuclear core and control rods is shown in Fig. 3. The lower cylindrical portion is the core cage which contains the fertile fuel elements and blanket assembly. The upper portion will be occupied by shafting and shrouds for the control rods.

Extensive instrumentation provides a maximum amount of experimental information from the reactor core in its operation. Thermocouples sheathed in stainless steel, 114 in number, measure temperatures of water and the fuel elements. Flow of coolant is monitored in selected seed and blanket clusters. Exit water from each of the 113 blanket assemblies is also sampled and monitored for fission products.

The light water used both for coolant and moderator is circulated from the reactor to four loops (one of which is a spare), each of which has its own heat exchanger, canned motor pump, check valve, and stop valves. The heat exchanger is in effect a boiler, where ordinary water is converted into 600-lb. steam (nonradioactive) to drive the turbine and 60,000-kw. generator. The piping for this system is made of Type 304 stainless steel hollow forgings, 18 in. diameter with 1.5-in. wall. Two types of heat exchangers are used, one a straight-through type, the other a U-bend type; in each the primary water (radioactive, coming from the reactor at 528° F. and 2000 psi.) flows through stainless steel tubing. The main coolant pumps are canned and, like the control rod drive assemblies, must operate without auxiliary lubrication directly in the primary water. In addition, several auxiliary systems are installed for pressurizing, and for charging, draining, venting, sampling of coolant and making chemical additions.

The entire primary system is contained in huge steel tanks shown in Fig. 5 and during construction in Fig. 4. A 38-ft. sphere houses the reactor vessel, two 50-ft. horizontal cylinders house the heat exchangers, and a third larger one contains the various auxiliary systems. All are designed to withstand a maximum pressure of 53 psi. and 280° F., as well as a 3-psi. vacuum. The entire volume totals 600,000 cu.ft., and is designed to be safe against a major break in the primary water system. The containers are made of SA 201, Grade B, firebox steel, 1¼ in. thick, the maximum which can be field welded without stress-relieving. Access is through air locks closed with circular doors, each weighing about 7 tons.

Blanket Fuel Fabrication

Much work was done to evaluate the blanket fuel, as outlined in the previous article, and it

was also necessary to develop fabrication processes for the 2,500,000 fuel pellets, 100,000 fuel rods, and 800 assemblies – all this in 18 months. The only form of UO_2 available to us was Mallinckrodt dioxide reduced from UO_3 in hydrogen. This powder possesses poor sintering characteristics, unless pressed at 125 tons per sq. in. This required carbide punches and dies. The schedule of operations consisted of agglomerating to incorporate a pressing lubricant and to convert the as-received powder to a free-flowing mixture; compacting to a green density of 73 to 74% of theoretical in automatic double-acting presses; presintering to remove binder and lubricant; final sintering in hydrogen to 93 to 95% of theoretical density in molybdenum-wound furnaces at 3050° F. for 8 hr.; and grinding all over to size to tolerances of ± 0.0005 in. on the diameter.

Zircaloy Tubing – About 15 miles of Zircaloy-2 seamless tubing was needed for the blanket. Most of it was made by one producer from billets hot extruded from arc-melted 12-in. ingots. Billets were jacketed in steel and copper and extruded into tube shells, de-jacketed and cold reduced to finished size by a series of tube-reducing, and mandrel-drawing and plug-drawing operations. Each cold reducing operation was limited to a reduction of about 45%. Intermediate anneals in high vacuum (1600° F. for 1 hr.) were necessary. All tubes were pressure-tested to 5000 psi. and further inspected by eddy current equipment. End caps were welded in a helium atmosphere and again inspected by helium leak testing and radiography. In order to fabricate the welded bundle shown in Fig. 3 of the previous article (p. 72, April issue) and preserve the spacings to the required tolerances, an involved welding sequence was necessary. Some of the distortion due to weld shrinkage was compensated for by strategically placed shims during final annealing of the bundle.

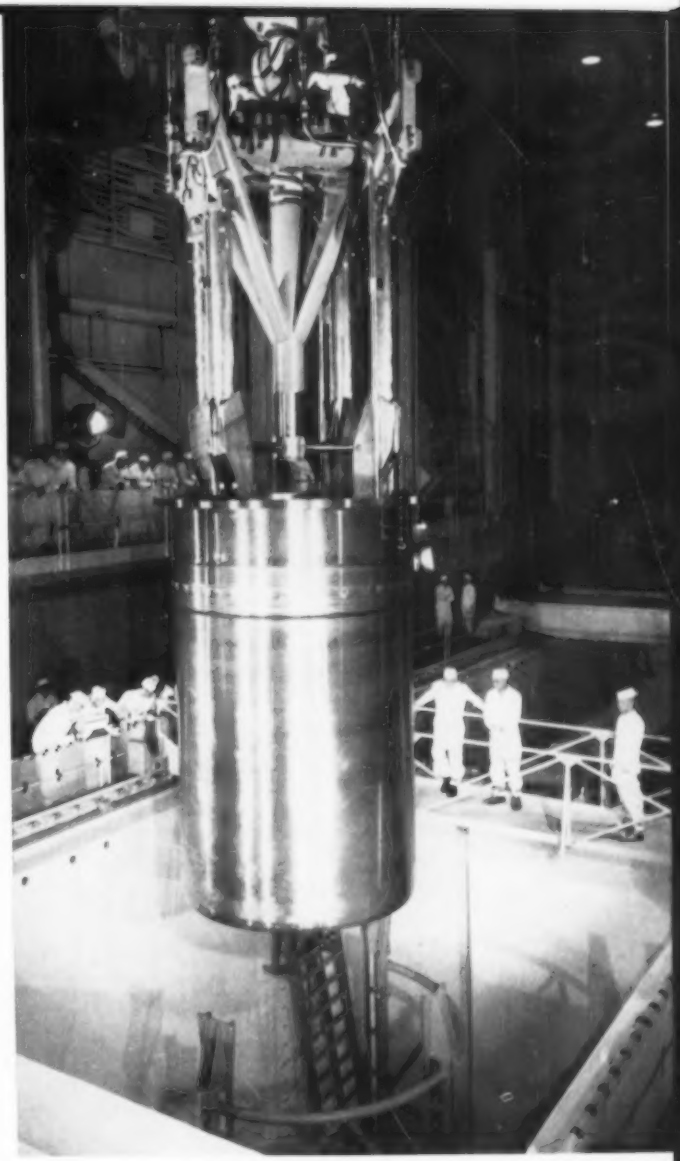


Fig. 3 – The Nuclear Core, Weighing 58 Tons and Containing 14 Tons of Natural Uranium and 165 Lb. of U^{235} Is Being Lowered Into the Reactor Vessel

Fretting and Mechanical Wear

Fretting is a ubiquitous difficulty with mechanical joints between components in reactor systems, and is rendered more acute by the fact that the circulation system is contaminated by the activated particles. The only preventive is through mechanical design since unfortunately metallurgists have not come up with any solution to this problem in the form of materials resistant to chaffing or wearing away under slight vibratory rubbing.

An example of the insidious fashion in which this operates, in spite of the fact that both designers and metallurgists did their best to avoid it, is the latch used to attach the seed assembly to the core structure. This latch is made of Type 304 stainless steel and is mechanically fastened to the Zircaloy-2 fuel clusters. A sample latch assembly was exposed to nominal working conditions (water flow and temperature) for six weeks, and sufficient vibration occurred to wear away the Zircaloy-2 surfaces as deeply as 0.10 in. (see Fig. 6). Fortunately this could be eliminated by a modified design.

The entire problem of wear and lubrication in high-temperature water systems is a fascinating and largely untouched field of metallurgy and surface chemistry. Wear rates of various com-

Fig. 4 – Progress View During Construction of the Shippingport Plant. Within the huge cylinders will be heat exchangers and auxiliary equipment. They are strong enough to contain radioactive steam in the event of a major piping failure

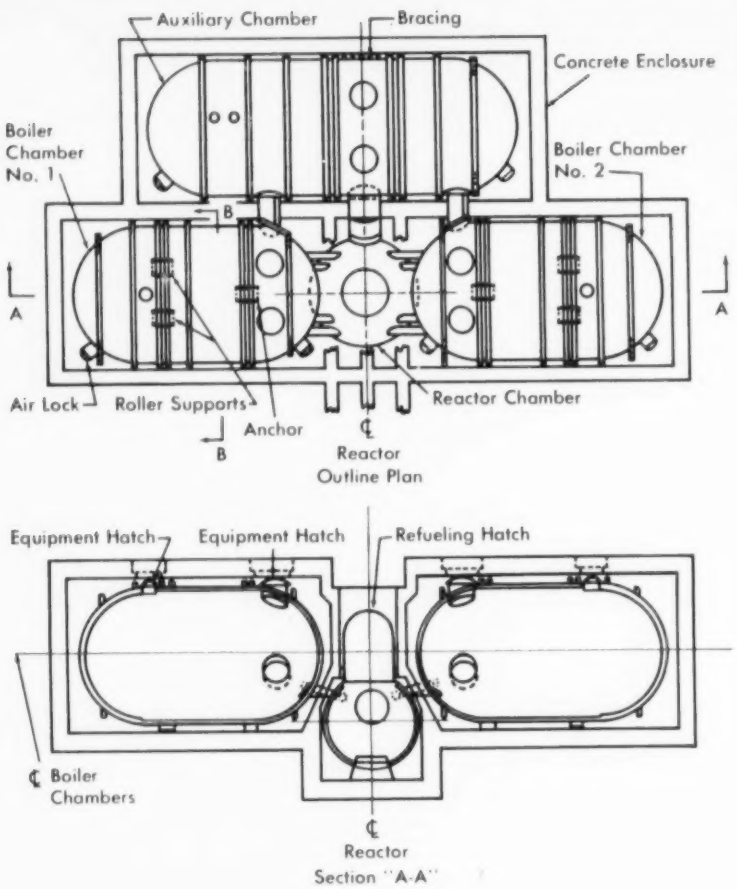


Fig. 5 – General Arrangement of Steel Containers for Reactor Plant. The reactor is contained in a sphere, the heat exchangers or "boilers" in two cylinders, and auxiliaries (blow-off tanks, pressurizers, flash tank, valves, monitoring equipment) in a larger cylinder

binations of materials vary by factors of thousands! This is important not only as it affects the operation of such mechanisms but also indirectly in the contamination of the system by the activated particles worn away. An interesting observation is that the addition of hydrogen to water, which is normal in PWR reactor operation, reduces frictional and wear rates almost by one order of magnitude as compared with similar observations in degassed or oxygenated water.

Cracking of Stainless Steel

The primary loop piping consists of Type 304 stainless steel, nominally 19-10 Cr-Ni, with 0.08% max. C. Stabilization is unnecessary because the primary water at operating temperature and pressure does not attack grain boundaries which may be depleted of chromium by precipitation of carbides. However, several instances have been encountered where the stainless steel cracked under somewhat abnormal conditions. For example, some of the 5-mil thick thermocouple sheaths in the core instrumentation showed profuse grain-boundary precipitation of carbides, accentuated by a heat treatment within the sensitizing range required to stabilize the thermocouples.[1] The cracking of the sheath was intergranular and presumably aggravated by the carbide precipitation.

Another instance was noted shortly after the plant started operations. Two of the tubes in one of the heat exchangers developed intergranular stress-corrosion cracking, starting from the secondary or cooler side of the tubes. This has not been encountered on a primary water environment in either test or operation of pressurized water reactors.

The Pressure Vessel

The pressure vessel was lined inside with a ¼-in. sheet of Type 304 stainless steel. A plate of proper thickness was bonded to the firebox steel slab by hot rolling; this was in itself a considerable extension of available technology to heavier sections. Considerable ultrasonic and other inspection was necessary to insure adequate bond quality.

As with any reactor pressure vessel, the increase in ductile-brittle transition temperature of the steel after neutron irradiation must be considered.* For our PWR pressure vessel, as for the EBWR, the principal thing you can do is to minimize the exposure of the pressure vessel steel to fast neutrons by adequate shielding, and by operating at temperatures which are so high that the "annealing" of structural changes induced by radiation is almost instantaneous.

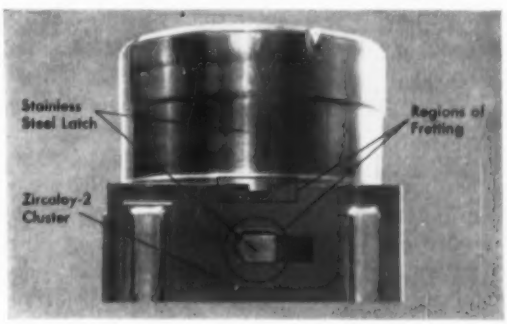
Of somewhat greater concern is to insure so heavy-walled a pressure vessel against brittle failure by providing adequate ductility in the steel and freedom from stress-raisers in the design and construction. Therefore the pressure vessel met the requirements of the A.S.M.E. Boiler and Pressure Vessel Code at 2500 psi., although the nominal operating pressure is only 2000 psi. All welds, nozzles, and other penetrations into the vessel were inspected to insure absence of stress-raisers.

Finally the steel was selected so as to obtain a combination of high strength and good ductility. It is a manganese-molybdenum steel conforming to A.S.T.M specification SA 302 Grade B, melted to fine grain practice, normalized at 1650 to 1750° F., and stress-relieved at 1150° F. after welding. Test samples were taken from each plate used in the vessel for chemical composition, physical and mechanical properties, and Charpy V-notch impact tests. The Charpy data were correlated by Pellini's nil-ductility transition temperature test – drop-weight tests on heavy sections. On this basis, a minimum of 15 ft-lb. impact energy in the Charpy test at 10° F. was requested for the new material. In addition, to insure that a flaw originally present in the material would not be propagated into a crack, a temperature of 110° F. (approximately 50° F. above the nil-ductility transition temperature) was set as the minimum for pressurized operation of the vessel.

The performance of the plant was analyzed under all conceivable conditions and combinations of reactor accidents to insure that the containing structure would prevent contamination of the surrounding community. Thus, the use of austenitic steel piping with its proven good ductility furnishes a built-in safeguard against sudden brittle rupture of hot water lines. However, we were concerned that the reactive metal, zirconium, which is so large a constituent of the core, might aggravate the severity of an accident.

A typical accident analyzed is known as the "loss of coolant accident", in which a major rupture, corresponding to sudden parting of an 18-in.

Fig. 6 – Fretting Damage Where Stainless Steel Latch Holds a Zircaloy-Clad Fuel Component



*The nature of this problem has been quite adequately discussed by K. F. Smith in *Metal Progress*, November 1957, p. 81, in relation to the experimental boiling water reactor (EBWR) pressure vessel at Argonne National Laboratory.

pipe, has been assumed to occur. If this break were to occur at the bottom of the core, if the accident were to occur during a period of extended full-power operation, and if the safety injection system which pumps water into the core were assumed to fail simultaneously, the decay heat from the fission products in the core would be sufficient to melt the hottest points of the reactor core within several minutes. It was necessary to prove by experiment and analysis that such melt-down did not lead to autocatalytic reaction between zirconium and water which could develop temperatures and pressures greater than the capacity of the plant container.

It was interesting to find that the reaction of molten zirconium droplets with water is limited by the heat lost from the droplets by radiation. Thus, even under the worst conditions, less than 20% of the molten zirconium would react and the pressures developed even under such circumstances can adequately be contained in the various chambers at Shippingport.

Coolant Contamination

One of the major considerations of design of the PWR (or for that matter any pressurized water plant) is the build-up of activity within the system and the consequent limitations upon the operations and maintenance. Economy dictates that the plant operate with a minimum of downtime. Therefore a major effort of the chemists was devoted to means of measuring contamination, identifying the source, and taking ameliorating measures. Measurements have been made of the activation of corrosion products formed on the stainless steel surface of the plant, sloughed from the surface in contact with the coolant, and transported through the core to other parts of the system where they can deposit. Such corrosion products, even though minute by any conventional standard, have significance to the maintenance of the system; close cooperation is required with metallurgists and designers to minimize the amount of such elements as cobalt in the metals and alloys. Cobalt, even though present in minute amounts, can constitute a major fraction of such activity by forming the highly radioactive isotope Co^{60}.

Such corrosion effects can be minimized by maintaining proper water conditions and by adopting suitable surface finishing and cleaning procedures. Dangerous levels of activity can also be avoided by a system which continually purifies a fraction of the reactor coolant flow. Other phenomena can contribute to system contamination – for example, particles worn from the hafnium control rod as they rub against the Zircaloy-2 walls of the channel. Another source of contamination is the exceedingly slight content of natural uranium in Zircaloy-2 (of the order of 1 to 2 ppm.) which contributes fission products by recoils from the surface, even though the corrosion film is very tenacious and does not slough off into the coolant.

Still another possible source of system contamination is the fission products released through a defect in the fuel element cladding. In fact, one of the major advances during the PWR development was the construction and operation of high-temperature water loops in various test reactors in which fuel elements containing intentional defects could be exposed and the release of fission products measured. It was established that fission products escape from Zircaloy-encased UO_2 pellets in a quite unique and predictable manner. Those isotopes which are quite volatile or soluble in high-temperature water (such as the noble gases, the halogens, and alkali metals) escape into the water stream at the highest rate; materials of somewhat lower solubility such as molybdenum and tellurium escape at somewhat lower rates; the alkaline earth elements strontium and barium at still lower rates; and such insoluble elements as the rare earths and zirconium at rates some four orders of magnitude less than those for the most volatile species. Fortunately those elements which escape from a defective fuel rod at the highest rates are the ones least readily absorbed on the walls of the system and hence are readily removed from the coolant in the purification system.

However, other factors which increase the formation of fission products also increase their release to water through a cladding defect. Among such factors are melting, excessive heat fluxes, and oxides of density less than 90%. These and other observations dictated the use of a densely sintered oxide as fuel in PWR Core 1.

Conclusion

Summarized above are some highlights of the many developments in metallurgical materials which were necessary for the Shippingport PWR plant – problems not only in the areas of research and development but often, and to a frustrating degree, in what seemed to be the most prosaic of "hardware". Fortunately, each of these problems was susceptible to satisfactory solutions. It must be the future contribution of metals and materials technology to the development of nuclear engineering to find ever cheaper and simpler solutions.

Continuous Furnace Improves Annealing

*By A. G. STURROCK**

Cycle annealing in a continuous furnace insures uniform structures in bars and throughout different lots of steel. Loads are carried through automatically after proper times and temperatures are selected. There are also provisions for protective atmosphere and carbon restoration. (J23, W27g, 1-61; ST)

IN MACHINING PARTS, screw machine shops need uniform material for consistent machinability on their automatic equipment. This obligates the supplier to furnish stock with consistent machinability throughout each piece. In fact, to avoid periodic resetting of machines, the lots themselves should be consistent. This is not easy. Uniformity of structure has been difficult or practically impossible to achieve with many batch-type annealing furnaces. Bars and lots have sometimes varied from 100% pearlitic on one end to almost complete spheroidization on the other. When this happens, costly and time-consuming re-treatment is necessary.

Why Uniformity Is Needed

Nonuniform structure has contributed more to poor machinability than all other factors combined. Although many other factors are involved in machining (such as tooling, cutting oils, operator, machines and others), the fact still remains that structure is fundamental. Along with uniformity of structure, it is essential that the supplier consistently reproduce the desired structure to the customer's specifications. Because machining setups vary from plant to plant, the structure best suited for a particular setup must be determined. Even when machining the same part, the same structure may not be suitable for different plants. If one machines the part on an automatic machine with light cuts and high speed, while another uses a turret lathe with a heavy cut and a lower speed, the first could use a pearlitic structure, while the latter might prefer a predominantly spheroidized structure.

To sum up, the machinability problem, as it concerns material, reduces to three main factors: uniform structure from the mill, knowledge of the customer's requirements and consistent reproduction of the structure with heat treatment according to specification.

Wyckoff Steel Co. had been meeting these requirements by laboriously annealing in two batch furnaces. In the first furnace, bars were heated and soaked until completely austenitized. Work was then transferred to a convection furnace for fast uniform cooling to the proper transformation temperature. Naturally such a process required much handling, particularly since the need for uniform heating necessitated small loads. Decarburization in the austenitizing furnace was also a drawback.

Continuous Annealing Furnace

Recently, a continuous furnace for cycle heating and cooling has been installed to do the job more efficiently and at higher production rates. Installed at the Chicago plant by Surface Combustion Corp., this furnace, 70 ft. long, combines continuous high production with automatic control. Better heating and cooling accuracy has been obtained, giving better control of structure of the bars. Since all elements of the bars move through the same temperatures, austenitizing and transformation are uniform. Figure 1 illustrates some features of the furnace. It operates automatically except for loading and unloading. Roller tables at either end (each 40 ft. long) provide easy charging and discharging. For

*Chief Metallurgist, Wyckoff Steel Co., Chicago.

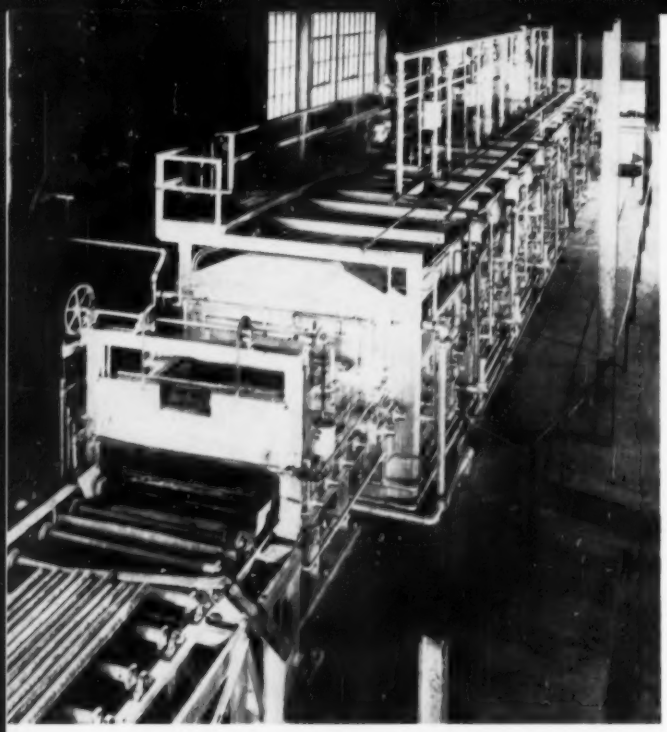


Fig. 1 – The 150-Ft. Cycle Heating and Cooling Setup Extends Across Three Bays. Vestibules at both ends prevent escape of atmosphere and also keep the furnace from being contaminated by outside air

general operation, the furnace heats to 1600° F., and cools 4000 lb. per hr. with a minimum of attention. However, it can operate at 1800° F.

Work travels through the furnace on rollers (35-15 Ni-Cr alloy) which extend through the sidewalls, mounted on water cooled bearings. The rollers, flanged to prevent work from striking sidewalls, are driven through sprockets and chains synchronized with the charge and discharge table rollers. Driven through variable speed transmissions, the chains provide proper speeds of travel for cycling the various size loads.

Many Cycle Possibilities

To provide flexibility of cycles, the furnace has six separate chambers. The first two are usually used for heating; the third, fourth, fifth and sixth can be used for either heating or cooling. A series of "W" type radiant tubes, placed above and below the roller hearth, heat the furnace. Cooling is accomplished by inspirating air at room temperature through the radiant tubes. Tube assemblies in the first chamber are installed with a bypass so that cooling rates can be controlled manually. Control of cooling rate in the other chambers is automatic. Inlet ends of the tubes are provided with a combination premix and diffusion burner; outlet ends have eductors that create a suction at the outlet end.* All burners are individually piloted.

Controlled Atmosphere Protects Surface

Work is always protected by RX generated and natural gas, or low-combustible, high-nitrogen NX generator gas. Carbon potential can be adjusted to provide a neutral or carbon-restoring atmosphere. Because the bars are spread across the hearth rollers in a thin layer (often only one layer deep), heating and cooling is fast and accurate, providing uniform structure and hardness along the bars and across the entire load.

An important feature of this furnace is its ability to restore carbon to bars that have been decarburized during hot rolling. Here again, accurate control of heating conditions and atmosphere potential is essential. Carbon restoration is especially important when bars are used for products that are induction hardened without machining certain areas of the original surface.

Atmospheres Are Automatically Controlled

The two types of atmospheres are supplied from two 5600-cu.ft. per hr. Surface RX (endothermic) generators and one 10,000-cu.ft. per hr. Surface NX (nitrogen) generator. The RX gas is monitored by a Surface Autocarb unit that controls dew point automatically at each generator, and a dew point recorder at the furnace. The latter records dew point on a strip chart, two samples at a time. However, sampling lines are manifold so that all six chambers can be sampled. A Bailey recording controller monitors total combustibles in the NX gas at the generator.

To provide sufficient circulation of atmosphere through the load, fans with alloy blades are mounted in the roofs of each of the first five chambers. These fans permit fast uniform heating of the load, and also promote fast uniform cooling when necessary. Furthermore, they provide ample circulation to mix natural gas with RX generator gas when higher carbon potential is required. Equipment to control temperature consists of one two-position and four single-point controllers, plus one controller with a 1400° F.

*This feature provides a long flame to heat the element evenly, and also inspirates the air that cools the element when desired. It also keeps the furnace atmosphere from contamination by combustion products. The tubes, because of the internal suction, are always at a lower pressure than the furnace chambers. If a tube leaks in service, the only loss would be a certain amount of furnace atmosphere sucked out through the tubes. If necessary, the furnace can operate until it is convenient to replace the tube.

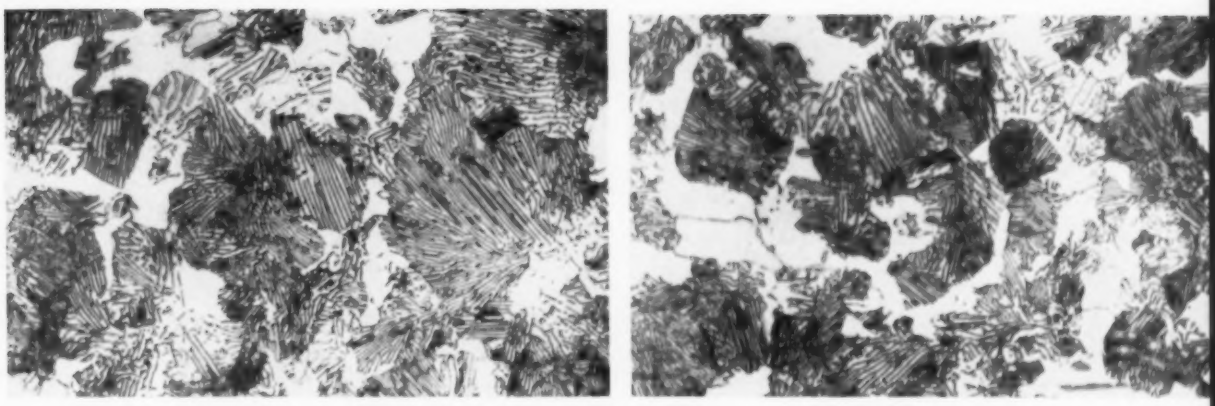


Fig. 2 – Photomicrographs of Annealed A 4140 (Left) and A 8642 Steel (Right) Show Almost the Same Uniformity and Distribution of Pearlite and Ferrite. Picral etch, 1000 ×

contact. All instruments record on strip charts. They are mounted on a single panel in a control room near the furnace. If the system fails, the operator is warned by an alarm; equipment is protected by gas shutoff valves and switches.

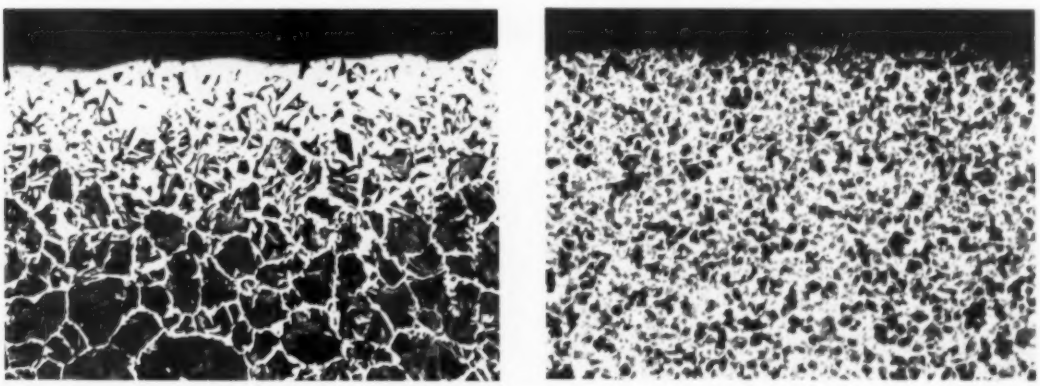
The Furnace in Operation

First, the required temperatures and atmosphere are established. The operator rolls the proper number of bars on the charge table, and they are started through the furnace. The work first passes through an air curtain at the furnace door, then through a vestibule (8 ft. long) containing four sets of heat resisting curtains formed of alloy strip. These help maintain the atmosphere. The bars then pass through two chambers that heat and hold the work at austenitizing temperatures. Depending on the size of the bars and the cycle, heating can be done in any of the first five chambers. After austenitizing, the bars are quickly cooled to transformation temperature as they pass through the cooling zones.

The bars then pass through a vestibule at the exit end (similar to the one at the charge end) onto the discharge table. As soon as the full load is on the table, the operator presses a button, and arms between the discharge rollers raise the load. This allows bars to slide into pockets that parallel the discharge table. When enough bars have accumulated in the pockets to constitute a "lift", they are routed for further processing treatment such as cold drawing or other finishing operations.

This furnace has been in service for several months and has demonstrated that results can be reproduced once proper austenitizing and transformation temperatures are established for the steel. Hardness and structure checks (see Fig. 2 and 3) made on samples from all positions of a load prove uniformity of conditions.

Fig. 3 – Structure of Surface of Coarse Hot Rolled, Decarburized C 1045 (Left) Compared With Steel Having Carbon Restored and Grain Refined. Picral etch, 100 ×



Metal Processing in Russia

*By ARTHUR B. TESMEN**

Continuous casting of steel, ultrasonic treatment of freezing metal, and vacuum rolling are all receiving attention from Russian metallurgists. The first is on its way to success; the others are only in the laboratory stage, but have interesting possibilities. (D9q, D9k, F23, 1-73; ST)

THIS ARTICLE on current Russian progress concerns three experimental processes (though continuous casting of steel is in the pilot-plant stage, as it is in this country). Both vacuum rolling and ultrasonic treatment of ingots produce interesting results in the laboratory; applying them on a production scale is likely to be quite a problem, however.

Continuous Casting

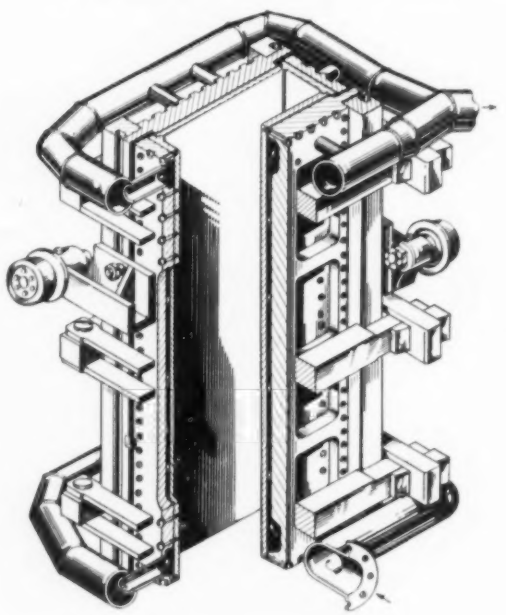
The installation I visited (one of four similar) was located at the Novo-Tula Metallurgical Works, about 150 miles from Moscow. These works are primarily used for the tryout and advancement of new processes and constitute an integrated mill with an oxygen plant, blast furnaces, openhearths, and the continuous casting unit. It has operated since 1953.

The Junghans-type unit casts rectangular ingots (up to about 8 by 24 in.), rounds and squares. At present they have successfully cast low-alloy constructional steels, toolsteels and are currently developing methods for low-carbon rimming steels.

The height – 72 ft. from the pit bottom to the pouring platform – was determined by the depth of the liquid phase of the ingot. This in turn determines the distance from the metal level in the mold to the ingot cutting torch. Depth of the liquid phase was determined experimentally by radioactive isotopes of sulphur and phosphorus; the experiments indicated that the depth was a function of cross-sectional shape and dimensions, speed of descent, steel analysis and the intensity of secondary cooling.

Experiments showed that the distance from the mold to the cutting torch (for largest ingots and a speed of 5 ft. per min.) should be about 40 ft. When provisions for the mold, secondary

Fig. 1 – Chill Mold for Continuous Casting. It oscillates up and down and is coated with liquid paraffin to prevent transverse cracks



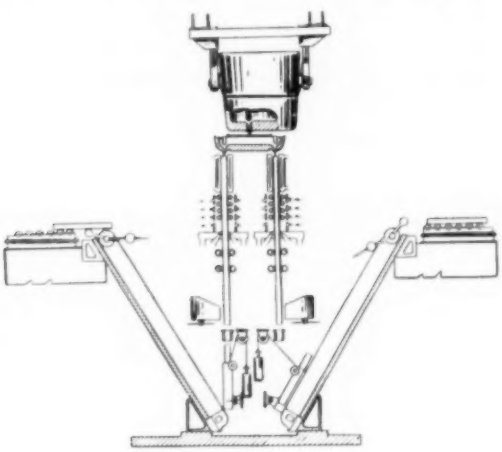
*Metallurgical Engineer, Loewy-Hydropress Div., Baldwin-Lima-Hamilton Corp., New York.

cooling, drive rollers, gas torch for ingot cutting, down-ender and roller conveyer were included, the total distance added up to 72 ft. Most of the equipment is installed in a pit 62 ft. deep, while the pouring platform with the chill mold, pouring tundish and the operating pulpit is placed 10 ft. above the floor.

In operation, steel is poured from a 10-ton ladle. When the metal level in the mold (shown in Fig. 1) reaches 12 to 16 in. from the top, the moving mechanism is turned on and gradually increases in speed until the desired speed is reached. The mold moves up and down; it descends to the depth of 1.6 in. at the speed of ingot descent but the upward movement is three times as fast. Average ingot descent is 3 to 4 ft. per hr. at average production of 30 to 40 tons per hr. Mold walls are lubricated with molten paraffin which, together with the mold's reciprocating motion, prevents sticking and transverse cracking of the solidifying ingot.

Upon exit from the mold, the ingot is still liquid at the center; it then enters the secondary cooling zone, where its surface is cooled by water sprays. The ingot skin at the exit is at about 2200° F. and, consequently, too weak to resist deformation due to the weight of the liquid metal at the center. Therefore, supporting rollers are placed along the entire secondary cooling zone (about 10 ft.). The rollers also aid in cooling. A gas torch cuts the solidified ingot while it is still descending.

Fig. 2 – Two-Strand Continuous Casting Machine



Another casting unit, shown in Fig. 2 at the Krasnoye Sormovo Works, casts two strands of rectangular ingots 7 by 16.5 in. from a 50-ton ladle. Casting speed is 3 ft. per min. at production rates of 50 to 60 tons per hr.

Mechanical properties of rolled, continuously cast, rectangular ingots are high (see Table I) and they have good surface quality.

Ultrasonic Treatment of Molten Ingots

The Central Scientific Research Institute for Ferrous Metallurgy (TSNIICHERMET, for short) in Moscow has been bombarding solidifying steel with ultrasonic waves to improve structure and properties.* Figure 3 shows the setup. Application of 10 kw. at 20,000 cycles to a magnetostrictive core causes vibrations which are transmitted to the solidifying metal through a cone-shaped concentrator and bar. The latter acts as a mold plug. Placed on the mold bottom is a steel block to prevent welding of the ingot to the mold. This equipment has treated induction-melted ingots weighing about 5 lb.

Microstructures of the treated ingots show grain refinement throughout, especially in steels of high nickel content. Steels without nickel, particularly those containing chromium, show this effect to a lesser extent. In cast iron and 25-20 Cr-Ni steels the dendritic structure was almost eliminated and segregation reduced. Inclusions are also reduced in size and distributed more uniformly. However, microporosity was found in zinc and aluminum alloys.

Fig. 3 – Diagram of Ultrasonic Treatment Setup

As to why ultrasonics work in this manner, the theory is that the transducer induces a fan-like upward movement in the cooling metal. Masses of tiny crystals resulting from the break-up of dendrites forming near the mold plug nucleate the fine grains.

The intensive agitation of the liquid metal aids homogenization and uniform temperature distribution throughout the ingot. This, combined with the numerous small crys-

*"Homogeneous Steel," *Metal Progress*, Dec. 1958, P. 63.

More Coming on Metalworking in Russia

Arthur B. Tesmen's article "Work on Metal Processing in Russia" and the one in the January International Issue of *Metal Progress* entitled "Welding and Metal Forming in Russia" were based on his trip to the U.S.S.R. last summer as a delegate to the Conference on Vacuum Techniques for Steel held in Moscow.

The editors are pleased to announce that starting in next month's issue Mr. Tesmen — as consulting editor to *Metal Progress*—will present the first in a series of authoritative reports on Russian metallurgy and metalworking which will appear every three months. Possessing a broad metallurgical background and a thorough knowledge of the Russian language, his articles will represent an important expansion in *Metal Progress's* coverage of current metallurgy.

Born in China (where he received his primary schooling and knowledge of Russian), he attended the University of Michigan and graduated in 1939 with a degree in metallurgical engineering. His "basic" metallurgical experience was obtained in the metallurgical departments of National Tube Co. and Crucible Steel Co. of America, interrupted by a wartime stint in the materials laboratory of the Philadelphia Navy Yard. Now a metallurgical engineer with Loewy-Hydropress Div. of Baldwin-Lima-Hamilton, he headed the development and application of iron powder welding electrodes for North American Philips Co., Inc., from 1947 to 1952.

Arthur B. Tesmen

tals distributed through the melt, results in fine and uniform grain structure. Formation of microporosity (eliminated when the zinc and aluminum is solidified in a vacuum) is explained by cavitation at the bottom of the ingot resulting from the air seeping between the mold plug and the mold opening.

Properties of Ultrasonically Treated Steel

Stainless steels of the 27 Cr and 25-20 Cr-Ni type generally solidify with a coarse grain structure. For this reason, the former has poor ductility and impact strength at room temperatures, and the latter poor ductility and strength at elevated temperatures. Cold working 27 Cr steel and hot working 25-20 is thus difficult.

Tests of the ultrasonically treated steels showed that though chemistry and gas content were not affected, reduction of area increased seven times and elongation three times. Thermal treatment decreased these changes somewhat. As-cast impact strength is increased 2½ times; hot worked specimens showed a four-fold increase in the impact strength. Workability tests of treated steels showed considerable improvement: Reductions per rolling pass can be doubled for the 27 Cr steel, and increased 1.3 to 1.7-fold for the 25-20 Cr-Ni steel.

According to TSNIITCHERMET, the principal obstacle in applying this method is lack of equipment for treatment of larger ingots.

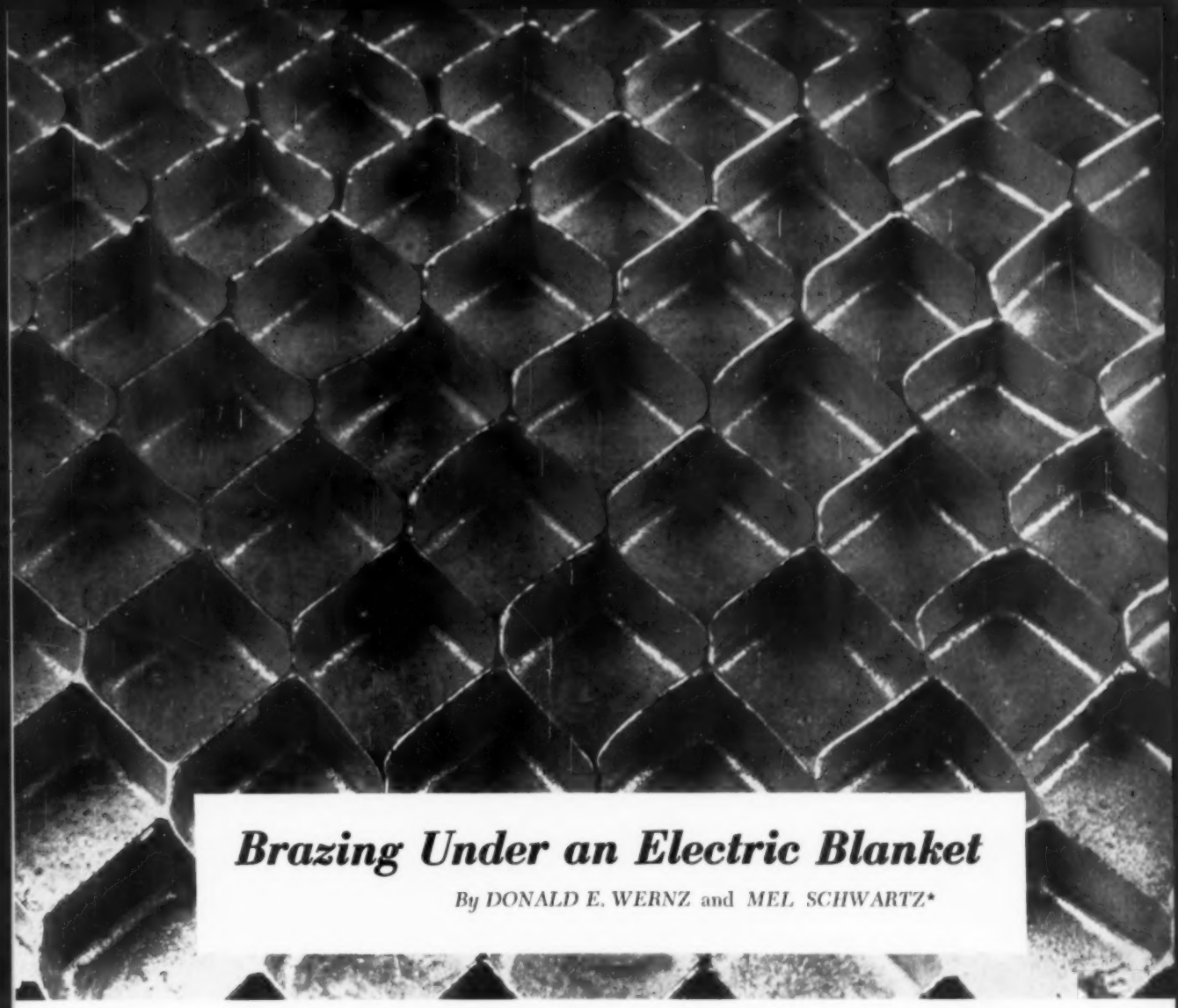
Vacuum Rolling

To study the effect of vacuum in hot deformation, TSNIITCHERMET has constructed a vacuum rolling installation consisting of a 6-in. diameter tube containing a miniature roll stand and a furnace. Entrance and exit locks, a roll drive inlet and a pumping system are also included. The unit can operate at 10^{-5} mm. pressure and has rolled levitation and crucible melted Cr steel, a 40% Cr-Fe alloy, a 19-28-3 Cr-Ni-Mo steel, and wrought iron. Rolling experiments were performed on small wedge-shaped specimens to permit a step deformation study. Tests indicated that a greater degree of deformation was possible; this was attributed to lower gas content in the vacuum-rolled material.

Table I — Mechanical Properties of Rolled Continuously Cast Ingots

Steel*	Reduction	Ultimate Strength		Elongation		Reduction of Area	
		Edge	Center	Edge	Center	Edge	Center
1026	6:1	87,000 psi.	87,000 psi.	29.0%	27.5%	47.3%	45.0%
1070	5:1	78,000	78,000	29.7	24.2	48.5	44.0
	8:1	78,000	78,000	30.9	27.6	50.8	46.0
	16:1	83,000	85,000	28.3	26.0	46.6	42.5
1086	16:1	88,000	91,000	29.0	26.7	50.7	46.2

*A.I.S.I. equivalents.



Brazing Under an Electric Blanket

By DONALD E. WERNZ and *MEL SCHWARTZ**

This new brazing technique appears as a substitute for furnace brazing in a number of applications. It is said to be cheap and efficient; equipment is compact. The method shortens production cycles considerably. (K8, 7-59)

THE IDEA of brazing with an electric blanket originated from a study involving simulated aerodynamic heating effects on a model wing. This investigation, by scientists at the University of Colorado, used a refractory blanket which pressed flat electric heating elements against a wing, causing it to absorb heat. It occurred to Martin scientists that this test fixture should be evaluated for brazing.

*Respectively, Supervisor, Manufacturing Research and Development, and Senior Manufacturing Engineer, Martin Co., Baltimore, Md.

Heating Problems Evaporate

The first attempts at Martin followed similar paths taken at the University of Colorado on evaluation of heating strips. Heating elements tested included Kovar, zirconium, ceramic coated stainless steel and Nichrome V. Nichrome V strips were best, but because the dielectric mate-

rial between the heating strips and the brazed panel was ineffective, the tests were not entirely successful. Finally a suitable dielectric, Refrasil, a leached silica woven cloth manufactured by H. I. Thompson Products Co., was obtained.

Blankets Cover Braze Structure

One of the first successful units, shown in Fig. 1, consists of an upper and lower ceramic "blanket", a cooling system and heating elements. Each blanket is made of insulating brick built on an aluminum framework with a network of steel pipes for water cooling which run through the bricks. Hose connections for these pipes are shown in Fig. 1.

On the inside surface of each blanket, heating elements of Nichrome V run the length of the blanket. This heat source produces 14 w. per sq.in. at 5 to 35 v. The temperature and voltage are regulated from a central control panel utilizing a 440-v., a-c., three-phase power supply. Thermocouples, embedded in the blankets, provide a constant reading within ± 25° F. for brazing and ± 10° F. for heat treating.

A refinement of the blanket brazing fixture is shown in Fig. 2. The sealed stainless (Type 301) envelope which contains the honeycomb panel rests on the surface of the lower blanket.

After the sandwich panel and silver-copper-lithium brazing alloys are located, the assembly is placed in the stainless envelope. Tubes are inserted, and the edges of the envelope are seam welded to make an airtight container. Of the tubes shown in Fig. 3 projecting from the sides of the envelope, two exhaust the air and the other two replace the air with argon to prevent oxidation of the panel. The argon circulating in the envelope maintains a positive pressure throughout the brazing process. The contents of the envelope are shown in Fig. 4.

In another experimental modification, a pressure bag is placed in the envelope. It is located on or under the assembled structure, and when filled with argon, supplies pressure to the honeycomb assembly. This arrangement is illustrated schematically in Fig. 5. The bag consists of two stainless steel sheets which are seam welded together and two gas tubes. The use of this pres-

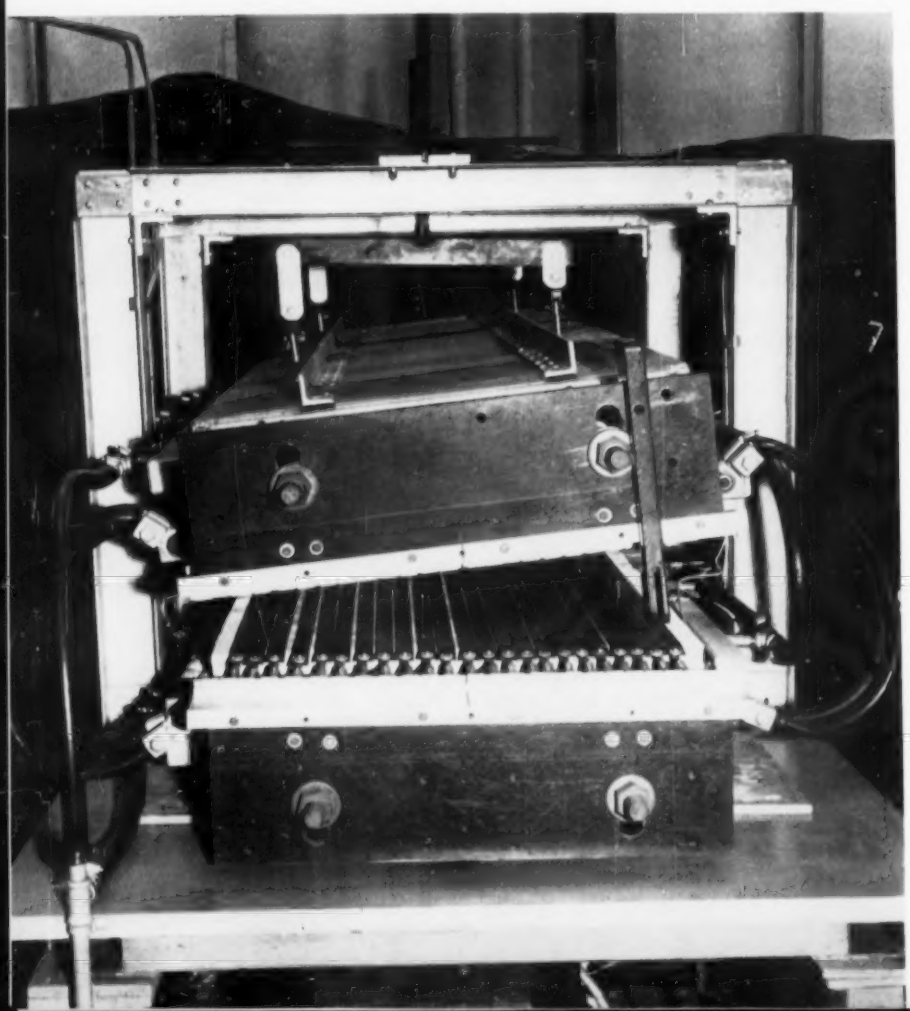


Fig. 1 — Fixture for Electric Blanket Brazing. Upper section presses down on the assembly. Electrical and water connections are made on each side

Fig. 2 – Latest Type Fixture for Electric Blanket Brazing. Unit is more compact. Electrical and water connections are made from one side. Springs hold the strip heating elements in tension

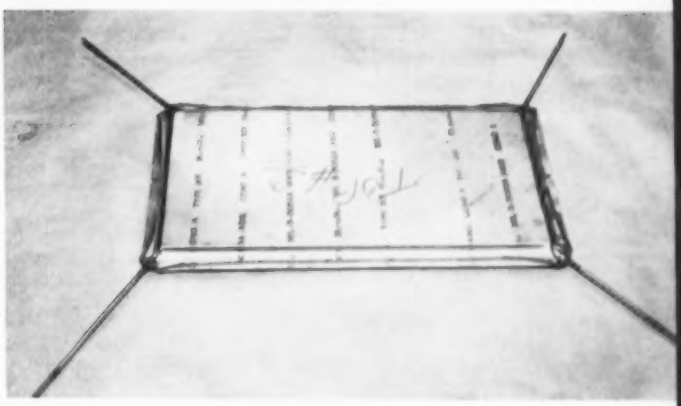


Fig. 3 – Sealed Envelope Contains Honeycomb Panel. Tubes exhaust air and pump argon into the assembly

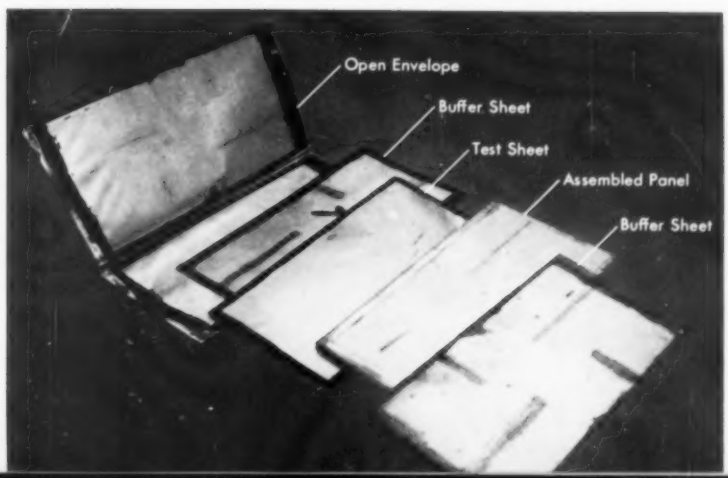


Fig. 4 – Contents of the Envelope. Like a woman's purse, it holds many items – two buffer sheets slit to compensate for thermal expansion, and a test sheet for checking physical properties

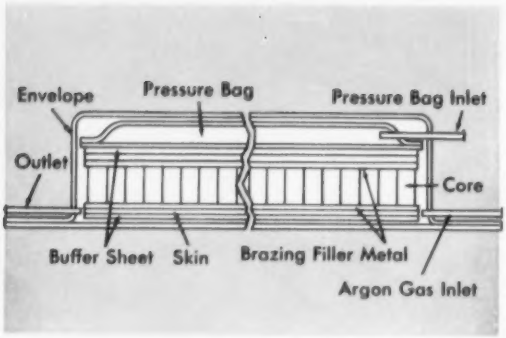


Fig. 5 – Schematic View of the Envelope and Its Contents

Heat Treatment

It takes some 45 min. to cool the panel to room temperature. The envelope is removed from the fixture, the purging tubes are sealed, and the panel is refrigerated to –100° F. for a minimum of 8 hr., depending on the mass. After the assembly reaches room temperature, it is replaced in the fixture. The purging tubes are re-opened, and argon is circulated while the envelope is brought up to 950° F. and held for 1 hr. for aging. Again, the assembly is water cooled, and when it gets down to 100° F., it is removed.

The brazing cycle takes only 2 hr. The complete operation (including heat treatment) requires 13½ hr. compared to 34 hr. using conventional furnace brazing. There is a marked increase in strength and a substantial reduction in weight over similar assemblies fabricated by the bonding process. The brazed panel retains its strength up to 1000° F.

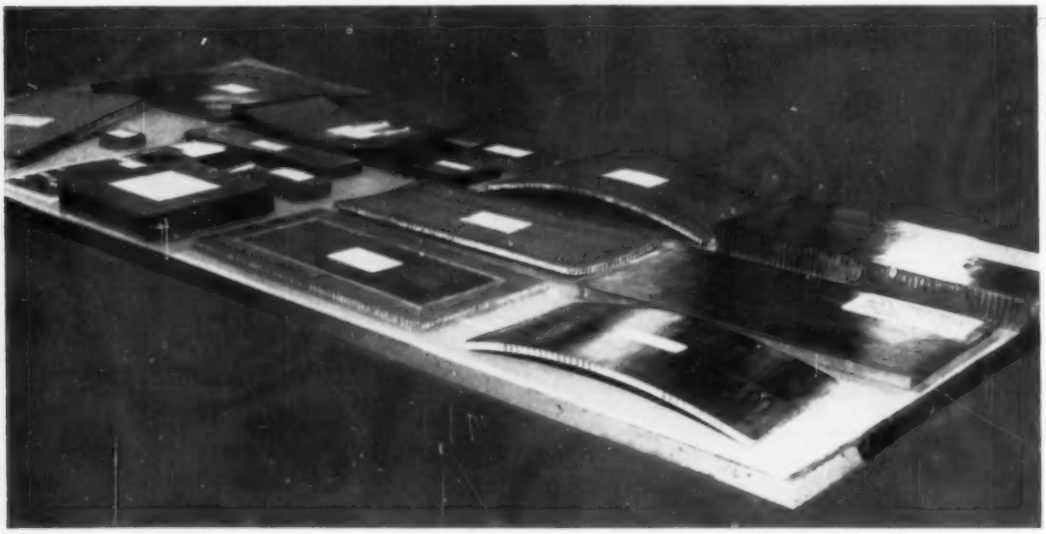


Fig. 6 – Panels of Various Size and Shape Brazed in the Electric Blanket Fixture

sure bag appears to improve the quality of the brazed structure.

The steel envelope is insulated from the lower heating strip by a layer of Refrasil material which prevents a short circuit. The assembled panel within the sealed envelope is checked for oxygen content. When the Cities Service unit indicates zero oxygen, the panel is ready for brazing.

Brazing Cycle

Next, the panel is locked in the fixture and the temperature is brought up to 1725° F. and held for 15 to 20 min. Water is circulated through the mixture during the heating cycle and the rate of flow is *increased* during the cooling.

The electric blanket operates at about 65% heat efficiency as compared to a much lower efficiency for furnace brazing. Also, the fixture is smaller and lighter than a comparable furnace unit. The power supply is mobile: One set will power several blanket brazing fixtures at different intervals.

The electric blanket brazing technique offers a new approach to manufacturing sandwich structures. Assemblies can be produced faster and at lower cost.

Short Runs

Rating Oil Stains on Cold Rolled Aluminum

*By L. B. SARGENT**

IN THE DRIVE TO CREATE, maintain and expand aluminum applications, a uniformly clean, attractive appearance is becoming increasingly important. The decorative and functional uses of aluminum in architecture, transportation, appliances, packaging and other fields require precise control of each factor that could mar a pleasing finish.

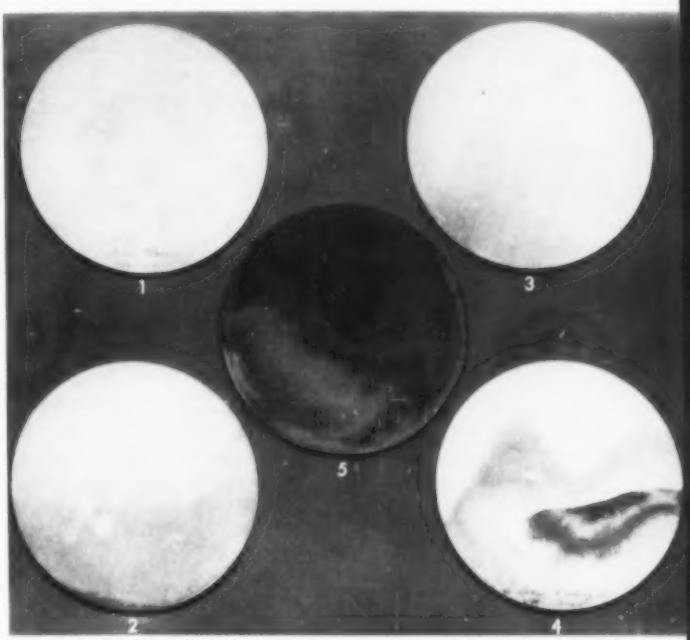
One such factor is the tendency of cold rolling lubricants to stain aluminum sheet and foil during annealing. Lubricants are required for rolling all aluminum and aluminum alloy sheet and foil. They help in gage reduction, and also prevent surface marking.

These lubricants are composed primarily of petroleum plus vegetable (or animal) type oils. Being organic fluids, they decompose at the temperatures required for proper metallurgical annealing, and residues, varying in color and intensity, appear on the product. The stain is very thin and tenacious; it is extremely difficult to remove. As of today, the only simple ways known are abrasion and exposure to temperatures above those required for annealing. Both methods possess objectionable features.

Obviously the most practical method for eliminating this stain is to use lubricants which do not produce discolorations. For the necessary rating, a laboratory method to determine staining characteristics of lubricants is first required. The method must correlate with mill experience, and be simple to perform. Different laboratories should also be able to reproduce results.

Over the last 15 years, a test which meets these requirements was developed. It is now in use in Alcoa's laboratories. Many of Alcoa's present and potential suppliers of cold rolling lubricants, as well as sheet and foil customers, use the test.

Fig. 1 – These Disks Are Used to Rate Oil Stains on Cold Rolled Aluminum



*Chief, Oils and Lubricants Div., Alcoa Research Laboratories, Aluminum Co. of America.

Oil to be tested (0.8 ml.) is applied by pipette to one side of a degreased Alcoa Aluminum Standard Stain Plate. These 0.064-in. plates are 5⅝ in. in diameter. Obtainable as Alcoa Aluminum Standard Stain Plates through Alcoa sales offices, they are specially fabricated. Uniformity of surface, flatness, and brightness receive particular emphasis. Users of the test make their own standards from standardized oils also available. The type and intensity of the stain produced by any given oil is, in a way, a function of the surface of the test plate. Thus, all laboratories employing this test must use the same kind of plate.

After oiling, the plate is placed on the floor of an electric muffle furnace which has been operated at 650° F. for at least 1 hr. before the test. After insertion, the plate remains in the furnace, with the door closed, for 30 min. Following removal and cooling, the stain on the plate is compared to a graded series of plates (Fig. 1) having standard stains. Duplicate stain tests are usually recommended.

Stains are of many colors and intensities. They range from barely perceptible discolorations through light brown, dark brown, greenish-red, and many combinations thereof, to black. The standardized stains used for comparison (numbered 1 to 5 in increasing order of color and intensity) represent several grades of these stains.

The standard stain test is sensitive to many factors. These include surface conditions of test plate, air flow through muffle furnace, flatness of test plate, oil composition, and temperature. To make certain that the test is controllable, periodic calibrations must be made using standardized oils and comparison plates.

We must caution those who try this test for used oils. These contain various contaminants. They make it difficult to interpret the resulting stains. Because of this, the test is used on new oils only. Tests on used or in-process lubricants require modification of the standard test.

This stain test has been incorporated for some time in our specifications for buying lubricants, and has provided good control of the lubricant with respect to stain-promoting tendencies.

Welded Aluminum Mine Cars

*By J. R. FLYNN**

The Watt Car and Wheel Co., Barnesville, Ohio, has produced all-aluminum mine cars, the first in the world. Although costing more than steel cars, they are lighter. Thus, an engine can haul more cars . . . and more ore. Design closely follows that of the welded steel mine cars. Watt is presently fulfilling an order from Hanna Coal Co. for ten cars which will be tested in actual operation at Hanna's Ireland Mine, in Moundsville, W. Va.

Each 7580-lb. car is 26 ft. long, 7 ft. wide, and 4 ft. deep. (A steel car of this size weighs 11,640 lb.)

All required parts for the order were cut out before assembly started. Then the 90 parts for each car were completely assembled and tack-welded before completing the seams. A total of 1300 ft. of sigma welding joins parts that make up each car. Trucks and draft gear are of steels. They are bolted to the body with 60 aluminized steel carriage bolts. The cars are constructed of 6061 TG, and most parts are ½ in. and 5/16 in. in thickness.

One question remains to be answered: Will the light-weight aluminum car endure the rugged wear and tear of underground mining? If so, it will reduce the per-ton cost of mining coal.

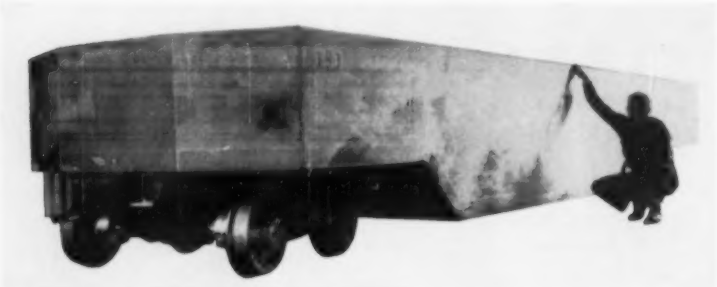


Fig. 1 — This Aluminum Mine Car, Produced by Watt Car and Wheel Co., Has a Capacity of 15 Tons.

*Welding Sales Engineer, Linde Co., Pittsburgh.

Graphitized Textiles Have Many Uses

GRAPHITE in a flexible fiber and fabric form is now available. National Carbon Co., division of Union Carbide Corp., has developed a process to convert organic textiles directly to graphite with over 99.9% purity.

Any textile form – yarns, braids and felts, or fabrics that are woven or knit – can be produced. In the complex process, now being patented, a fiber or fabric such as rayon is heated by electricity to a temperature approaching 5400° F. The thermochemical reaction which occurs changes the crystalline structure to that of graphite.

Graphite's unique combination of electrical, chemical and mechanical properties – coupled with the wide variety of textile forms now available – promises significant applications for the new material. At ordinary pressures, graphite has no melting point, going directly from solid to vapor at about 6600° F. Its tensile strength at 4500° F. is about twice that at room temperature. At the low end of the temperature scale, the known properties of graphite fabrics are unaffected by liquid nitrogen at –320° F.

Graphite textiles resist attack by acids, alkalis, and organic compounds (except those that are highly oxidizing), and do not react with molten metals. They have excellent electrical and thermal conductivity, and, being in flexible form, are immune to thermal shock. Graphite is also a useful lubricant.

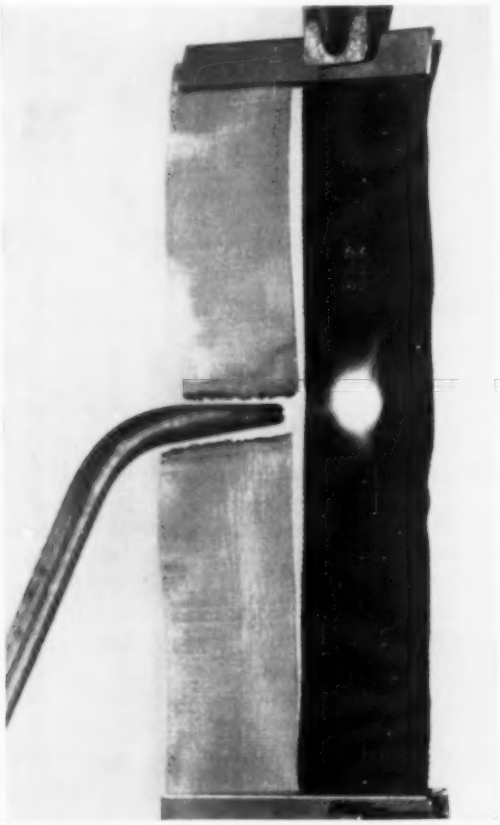


Fig. 1 – Blowtorch Melts Stainless Steel but Does Not Affect Graphite Cloth

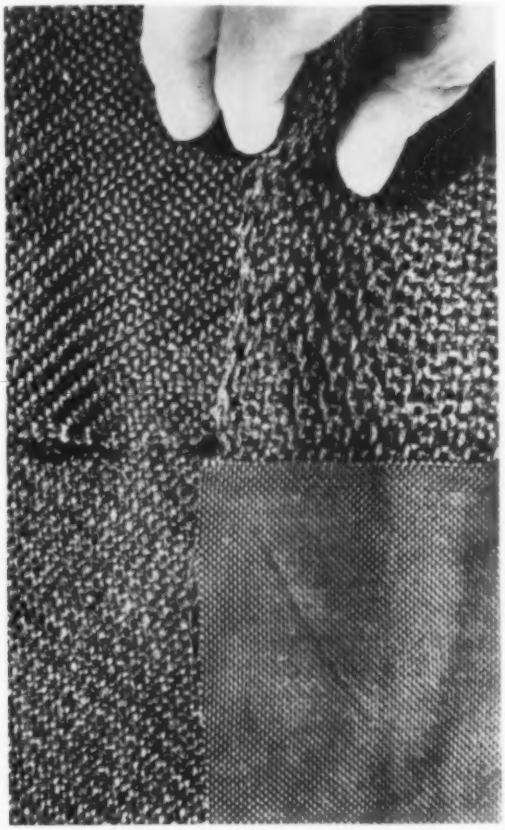
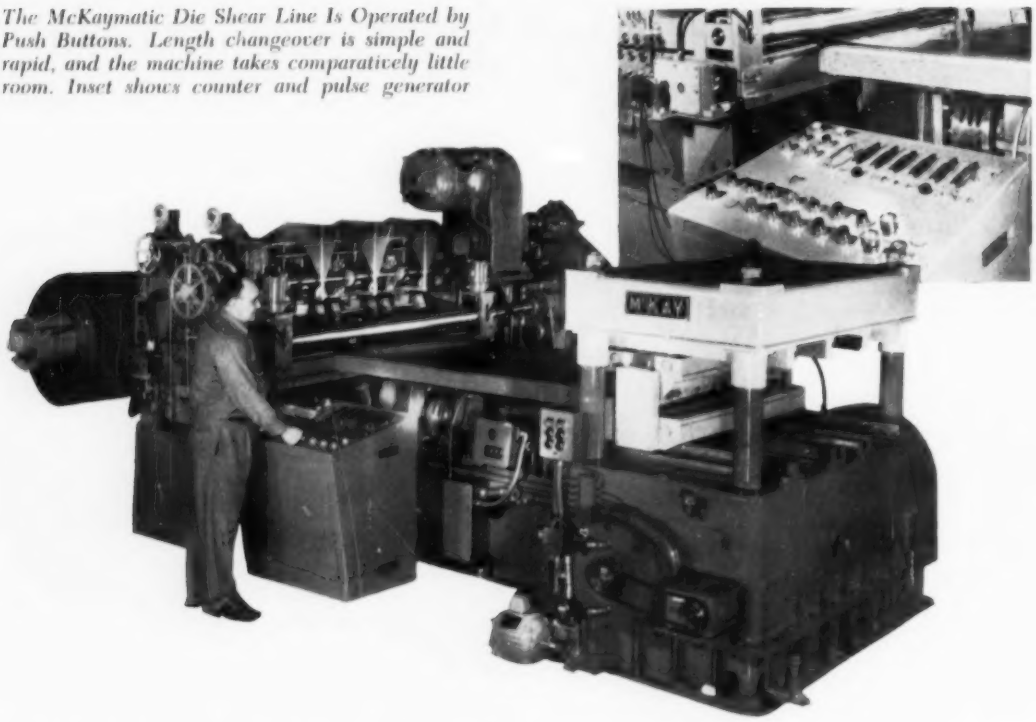


Fig. 2 – Wide Range of Textiles Can Be Graphitized. Here are four examples

Possible Uses Are Legion

One field in which graphite cloth is being evaluated is as a reinforcer for various plastics

The McKaymatic Die Shear Line Is Operated by Push Buttons. Length changeover is simple and rapid, and the machine takes comparatively little room. Inset shows counter and pulse generator



and refractories used at high temperatures, such as nose cones for missiles. (Figure 1 illustrates its resistance to heat.) Graphite fibers and fabrics can impart electrical and thermal conductivity to nonconducting materials such as plastics, ceramics and even to other textile materials such as glass cloth.

In chemical applications, graphite cloth is being considered as a filter for hot nonoxidizing gases and for equipment to handle corrosive fluids. It can be used for resistance heating elements to put heat exactly where it is wanted at very high temperatures. Low-temperature panel heating could include wall units for homes, or perhaps heated clothing for space travelers.

Electronic possibilities include thermo-electric elements, vacuum tube grids, and infrared emitters. Other potential electrical uses are as static eliminators, and possibly even as a filament material for incandescent lamps.

Mechanically, the cloth could be used for valve packing and gasket materials for high-temperature seals such as those in jet engines. Conveyer belting for high-temperature process equipment is another possibility.

At present, experimental quantities of graphite fibers and fabrics are being supplied for test and evaluation throughout the country. Figure 2 illustrates four typical weaves.

Push Buttons Operate New Die Shear

A DIE SHEAR operated by electronic controls has been introduced by McKay Machine Co., Youngstown, Ohio. Speeds of about 200 ft. per min. are possible with this setup, which is now being patented. Several unique features make this a versatile machine.

Through electronic control, gaging of sheet length is extremely accurate – within 0.01 in. Furthermore, changeover to another size is quite rapid. As the illustration shows, the shear is controlled by push buttons in the small console. These monitor an electronic counter which is actuated by a pulse generator.

Operation is simple. As the sheet leaves the coil, it runs through a roller leveler and between the two rolls at the head of the table. The bottom roll is connected to the pulse generator – as it turns, pulses actuate the counter. When the desired length is reached, an air clutch closes to synchronize the shear table with the moving sheet. The shear then closes to cut the sheet. Since the sheet does not stop, there is no buckling and no further roller leveling is needed. Pushing the appropriate buttons changes the length.

The setup requires little room, is easily adjusted through conventional a-c. drives and controls, and can be adapted to a great number of gages and sheet lengths. Shear dies can be easily altered to punch holes or slits if necessary. All in all, many sheet purveyors and fabricators are likely to find this a very useful item particularly where quantities of mixed lengths are needed.

Beryllium Is Now Being Forged

WYMAN-GORDON CO. has announced the forging of large parts from beryllium. Shown on the bed of the 18,000-ton forging press is a typical part. The closed-die forging technique helps eliminate beryllium's excessive brittleness to give more ductile material. This marks an important advance in forging since the brittleness of beryllium had heretofore made it extremely difficult to form.

Because of its lightness (it is a little heavier than magnesium) and strength (modulus of elasticity is one and one-half that of steel), beryllium is considered an ideal metal for future space ships and missiles. As an example of the weight savings possible, consider this. If beryllium is used in the last stage of a three-stage moon rocket, the rocket could be 400 lb. lighter. This means that 2000 lb. less fuel would be needed for the third stage. In turn, 200,000 lb. less fuel would be needed at launching. The higher cost of beryllium could easily be offset by these economies.

Beryllium Forging Is Shown on the Bed of the 18,000-Ton Forging Press Which Produced It. Larger presses at Wyman-Gordon (including a 50,000-ton forging press) will be used for larger and more complicated parts

Titanium + Palladium = Better Corrosion Resistance

WHEN TITANIUM is alloyed with small amounts of platinum, palladium, rhenium or other noble metal, the corrosion resistance is improved markedly. This is the basis for a new titanium alloy which contains 0.10 palladium. Its production can be licensed through Union Carbide Metals Co., division of Union Carbide Corp. Evolved under the direction of Milton Stern of the Metals Research Laboratories in Niagara Falls, N. Y., this new alloy is said to offer unusually broad resistance to both oxidizing and reducing media. Figure 1 compares it with several other corrosion resistant metals. Prior to this discovery, titanium was well known for its ability to resist corrosion in extreme oxidizing environments; it now has much wider use as a constructional material, in pumps, valves and other equipment for the chemical industry.

In reducing environments, such as hydrochloric and sulphuric acids, titanium has been under a severe handicap. For example, in a boiling 5% solution of hydrochloric acid, titanium dissolves more than 1 in. per year. With 0.1% palladium, corrosion attack is lowered to less than 0.01 in. per year. Tests of the mechanical properties of this alloy show that they are the same as those of unalloyed titanium. The palladium-bearing titanium can also be cold and hot worked without difficulty.

In developing the new alloy, Dr. Stern advanced an electrochemical theory for the role of noble metal additions on corrosion passivity. A noble metal is essentially insoluble in the corrosive environment and has a high exchange current for the hydrogen ion reduction process. When added to a metal such as titanium, a noble metal appears at the alloy surface to create a galvanic couple which acts as a site with a low-hydrogen overvoltage. This results in passivity and a marked decrease in the rate of corrosion.

Some discussion of the theory behind this discovery might be worth while. According to Dr.

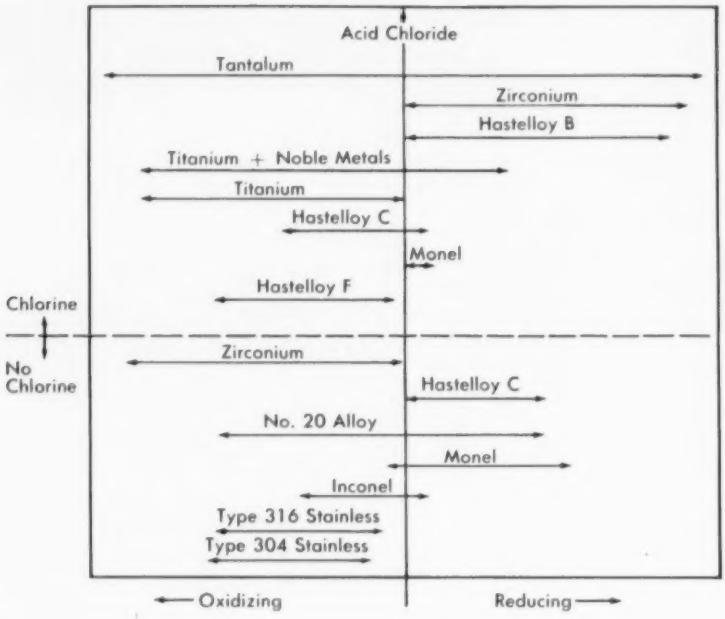


Fig. 1 – Comparison of Titanium and Titanium-Noble Metal Alloys With Other Corrosion Resistant Alloys. Each alloy will handle all environments below its solid line

Stern, passivity can be accomplished by alloying an active metal, such as titanium, with an element which is essentially insoluble in the environment and which exhibits a high exchange current for the hydrogen ion reduction process. A small amount of corrosion should leave the alloy addition essentially in elemental form on the surface which is thus converted to a galvanic couple one of whose constituents presents a low-hydrogen overvoltage surface. The exchange current for the hydrogen reduction reaction on titanium is very small, resulting in an active mixed potential. When alloyed with metals like platinum or palladium, regions with very high exchange currents are produced on the surface, creating a mixed potential in the passive potential range. This results in a markedly reduced dissolution rate.

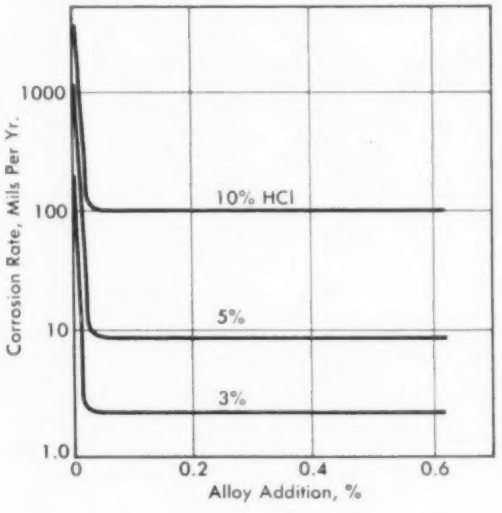
Though this qualitative theory does not permit an estimate of the alloy concentration required to produce a maximum effect, observation of the effect on corrosion rate should reveal a composition above which no additional benefit is gained. This is the concentration sufficient to produce a mixed potential more noble than the critical potential for passivity.

The effect of platinum and palladium additions to titanium in boiling hydrochloric acid solutions is shown in Fig. 2. For boiling sulphuric acid, a higher percentage of noble metal is required.

This alloying is not detrimental to behavior in highly oxidizing media, such as concentrated nitric acid or ferric chloride.

At first glance, the economics of noble metal additions may be misleading because of the high prices involved. Though palladium costs about $19 per troy ounce, the cost of palladium additions of up to 0.1% is about 28¢ per lb. of titanium. Since titanium mill products are selling currently at prices as high as $12 per lb., the additional 28¢ is quite reasonable considering the potential benefits.

Fig. 2 – Effect of Platinum and Palladium Additions on Corrosion Rate of Titanium in Boiling Hydrochloric Acid Solutions



Far Faster...
Lower in Cost...
Improves Quality

by providing sound, uniform, close-tolerance brazes

Complicated aluminum tube "nests" (like this) are brazed fast and economically in this Ajax installation in a well-known California plant

DIP BRAZING OF ALUMINUM ASSEMBLIES Gives Production a Big Boost

Do you get "Salt Bath Tips & Trends"?

Chock full of valuable heat treating information, this little Ajax house organ is issued four or five times each year. A note on your company stationery will put you on the list to receive it.

Even highly complicated aluminum assemblies can be handled better and faster . . . on a mass production basis . . . in inexpensive Ajax Salt Bath Furnaces engineered for maximum efficiency on your particular application.

Costs are reduced and brazing quality materially improved. All joints are brazed quickly and simultaneously. Distortion is negligible. Polished aluminum surfaces offer no problem. Extremely close temperature control eliminates the possibility of overheating.

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Book Review

A Useful Appraisal of Radiation Effects on Materials

*Reviewed by JOSEPH M. BEESTON**

THE EFFECTS OF RADIATION ON MATERIALS, edited by J. J. Harwood, H. H. Hausner, J. G. Morse and W. G. Rauch, Reinhold Publishing Corp., New York, 1958, 355 p. $10.50.

THIS BOOK IS BASED on a March 1957 conference sponsored jointly by the U. S. Office of Naval Research and the Martin Co. at Johns Hopkins University. The organizers of the conference, who are also the editors, concerned themselves with the effects of radiation on metals, dielectrics, semiconductors, and organic and polymeric materials; each chapter, covering a particular phase of the field, is written by a specialist. The book will appeal to research scientists and engineers working on radiation effects as well as those concerned with the development and design of structural components and instruments for reactors. College students will also find it readable and informative. In addition to referenced statements throughout, the book contains a bibliography of 779 references.

Because of the multiple authorship, it is not surprising to find some repetition. For example, the discussion of the dimensional changes that occur in graphite upon irradiation in the chapter on "Defects in Solids and Current Concepts of Radiation Effects" is repeated in the chapter on "Moderators, Shielding and Auxiliary Equipment". The editors generally have done a good job, although readability is adversely affected at times by an overabundance of detail.

Considering the newness of the subject matter, one is not only impressed with the thoroughness of the presentation, but also concerned about the need for supplementary experimentation. A statement on p. 104 is an example: "The net result of the irradiation process appears to be toward the promotion of thermodynamic equilibrium. Apparent important exceptions to this generalization have been found in U-Mo alloys . . ." These exceptions occur fairly frequently; however, the concise treatment will be valuable to those studying radiation effects.

The excellent resume of both fundamental and structural effects makes the book particularly useful to engineers and scientists who are starting work on radiation effects as well as those who are only occasionally interested. Metallurgists working on structural parts and instruments for reactors will also appreciate the wide coverage.

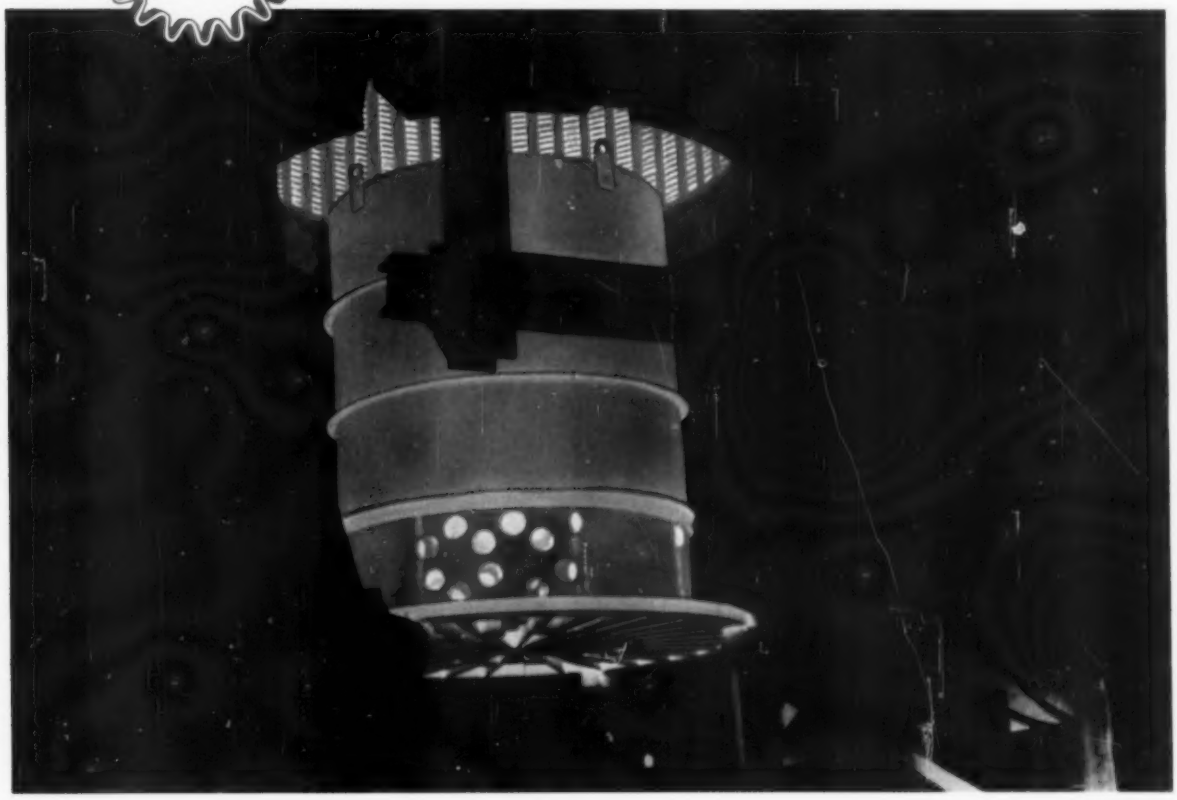
As a textbook for college students interested in nuclear engineering, the book has definite limitations: First, it was assumed that those attending the conference had some acquaintance with radiation effects and the nature of the solid state; second, the development of equations and presentation of fundamental ideas is generally glossed over quickly. Perhaps the first limitation is not as serious as the second, because most engineering curricula are including courses designed to give the student some acquaintance with the solid state. But it is doubtful that he would have enough familiarity with Bragg's law of diffraction, threshold energy for displacement, p-type and n-type semiconductors, and F-centers to master several parts of the book.

The importance of quantitative measurement of the amount of radiation received and the difficulties of making this measurement are recognized by several of the authors. Possibly more space than five pages could have been devoted to this problem in the chapter on "Experimental Approaches to Radiation Studies". This chapter should interest college investigators starting radiation-effects programs.

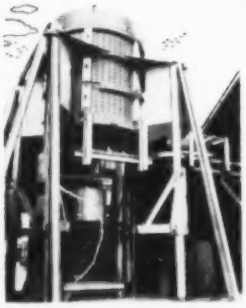
The authors have organized their material thoroughly. The index is helpful as it now stands, but inclusion of more detail would add to its usefulness. The liberal use of clear figures and detailed illustrations is commendable. The reviewer highly recommends this book.

*Metallurgist, Atomic Energy Div., Phillips Petroleum Co., Idaho Falls, Idaho.

KANTHAL heating elements



...again selected by PACIFIC SCIENTIFIC for gigantic SOLAR honeycomb brazing furnace



BIGGEST YET! This unique elevator type brazing furnace is the only one of its kind in existence today. Towering 35 feet high, inside dimensions 8 feet by 10 feet, loading capacity of 4000 pounds, power input of 610 KW. Numerous new features enable the furnace to braze, on a production basis, honeycomb panels that will withstand 1600° F. continuously and 2000° F. intermittently.

This unusual furnace built for Solar Aircraft by the Pacific Scientific Company of Los Angeles met rigid design specifications in order to provide extremely close temperature uniformity with fast heating and cooling. Met them so well – in fact – that Solar ordered another similar furnace.

And in both furnaces – KANTHAL A-1 RODS were selected for the heating elements. According to Pacific Scientific . . .

"Kanthal Rods provided the ideal elements for these honeycomb brazing furnaces. A protective oxide film produced by aluminum in the rod alloy at the elevated temperatures permits the wire to give extremely high temperatures for long periods of time without failure when operated in an air atmosphere. Kanthal A-1 elements were used because of their ability to work at these elevated temperatures and to provide excellent service life."

These two Pacific-built Solar furnaces are among the largest KANTHAL installations of rods. Their satisfactory performance is the result of constant KANTHAL research to provide engineers with a broader and better means to solve heating and resistance problems.

Whatever your requirements – KANTHAL can provide an efficient, economical element to meet your needs.

For further specific information and application data – write KANTHAL TODAY!

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Correspondence

Aluminum Powder Parts at High Temperature

NEW KENSINGTON, PA.

The November 1958 issue of *Metal Progress* contained Part I of two very interesting articles by L. P. Jahnke and R. G. Frank on "High-Temperature Metallurgy Today". Their discussion of basic strengthening mechanisms was of particular interest to the Alcoa Research Laboratories because of our work on aluminum powder metallurgy products containing finely dispersed particles of aluminum oxide and intermetallic compounds. In Table II of this article, however, they list 550° F. as the highest temperature at which an aluminum alloy provides useful strength. Their footnote indicates that the criterion used was a required stress-rupture value of 10,000 psi. for 100 hr.

However, there are some aluminum powder metallurgy products which exceed this value at temperatures above 550° F. Below are listed 100-hr. rupture strengths at 600° F. for M 486 alloy made from atomized powder, and M 257, M 470 and M 430 alloys made from milled powders of various oxide contents.

M 486	16,000 psi.
M 257	11,500
M 470	14,000
M 430	15,500
X 2219-T 6	9,000

At 600° F. all of these alloys exceed the 10,000-psi. required value, while the wrought alloy X 2219-T 6 made from ingot in the conventional manner is just below it. At 700° F. M 486, the only alloy for which data are now available, meets the requirement, and M 430 alloy is also expected to meet this requirement.

The yield strengths (0.2% offset) of M 486 alloy at 600 and 700° F. exceed by a substantial amount the 100-hr. rupture strengths listed in the table. This condition should hold true for the other powder metallurgy alloys as well. Other properties of M 486 were given in an article by myself in the May 1958 issue of *Metal Progress*, and J. P. Lyle, Jr., published properties of M 257 in *Metal Progress*, December 1952.

The aluminum powder metallurgy alloys have been produced for some time and are commercially available. The M 257 alloy has been sold for commercial use in the form of extrusions and forgings. Also, M 257 sheet over 3 ft. wide can be produced in pieces weighing up to 200 lb. The M 486 alloy has been fabricated in the plant as extrusions, forgings and sheet. For the most part M 470 and M 430 alloys have been limited to extruded shapes.

R. J. TOWNER
Research Engineer
Alcoa Research Laboratories

Quality Control in Specialty Steel Production

Reading, Pa.

In our article "Quality Control in Specialty Steel Production," which appeared in the November 1958 issue of *Metal Progress*, an error in the original manuscript was carried over into the article. In the section on p. 101 under the heading "Solidification Mechanism", the second sentence reads: "High-purity metal freezes first and the remaining molten metal has a *higher* freezing temperature because of the alloying elements and impurities." Obviously, the word "higher" should read "lower".

J. S. PENDLETON, JR.
H. O. BEAVER, JR.
Metallurgists
Carpenter Steel Co.

Metallurgical Dragon

MIDLAND, MICH.

We would like to add another "metallurgical dragon" to your collection of prehistoric monsters (*Metal Progress*, March 1958, p. 112). This electron micrograph was taken from a replica of a commercial Mg-Al-Zn alloy in the solution heat treated and aged condition. It has not been positively identified, but looks very much like an open-mouthed reptile about to devour a delectable morsel of $Mg_{17}Al_{12}$.

C. A. MOE
Fundamental Research
Metallurgical Laboratory
Dow Chemical Co.

Electron Micrograph of Mg-Al-Zn Alloy. 4500 ×

(*More correspondence on p.* 124)

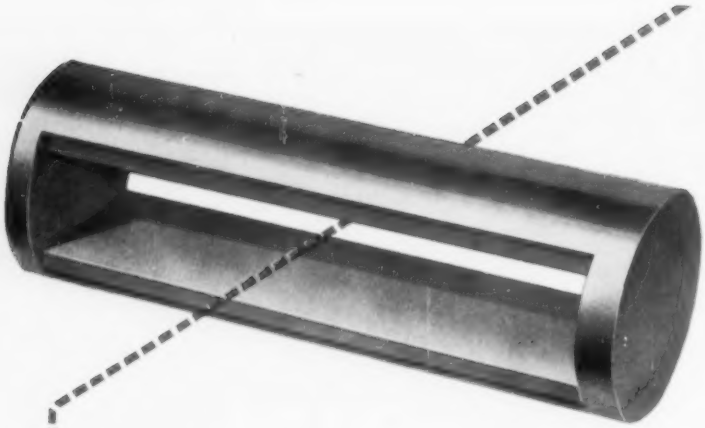
New "washing machine" makes CLEAN stainless steel

More often than not, titanium-bearing stainless can hike your fabrication costs . . . due to subsurface stringers or banding that cause excessive scrapping of parts. At Eastern, however, these harmful inclusions come out in the "wash."

Eastern's exclusive slag wash melting process produces the *cleanest* titanium-bearing stainless you can buy . . . exceptionally free from non-metallic contaminants . . . and at *no extra cost.* Eastern's new high-capacity slag furnace will meet industry's growing demand for such titanium-bearing steels as 321SW, 19-9DL, A-286, 19-9DX. Which do *you* need—and how fast?

EASTERN STAINLESS STEEL

Baltimore 3, Maryland, U. S. A.



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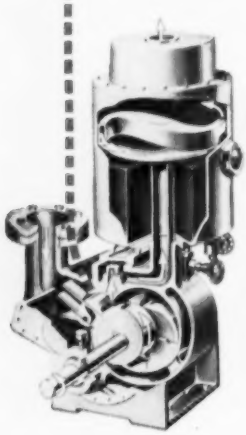

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KINNEY—the top name in High Vacuum—offers the broadest selection of Single-Stage, Two-Stage and Mechanical Booster Pumps in the world with free air displacements from 2 to 5100 cfm. Single-Stage Pumps developing pressures of 10 microns*... Compound Pumps developing pressures of 0.2 micron* and Two-Stage Mechanical Booster Pumps developing pressures to 0.1 micron*.

*McLeod Gage

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Oxy-Acetylene Flame

SHOTTS, LANARKSHIRE, SCOTLAND

The digest of the article "Characteristics of Refractory Oxide Coatings Produced by Flame Spraying", by Neil N. Ault, which appears on p. 141 in *Metal Progress* for March 1958, contains a statement which should not stand unchallenged. On p. 142 near the top, I read "An acetylene-oxygen flame is generally highly oxidizing . . ."

This statement may apply to an acceptable oxy-acetylene flame on a spray torch, but is definitely not applicable to the normal setting used on a welding blow pipe. In the latter, the setting produces a "neutral" flame and in many cases the flame is set to be slightly reducing to mild and low-carbon steels. A properly adjusted oxy-acetylene flame yields an atmosphere of H_2 and CO inside the flame, which might be objectionable in a spray-torch used to apply refractory oxide coatings.

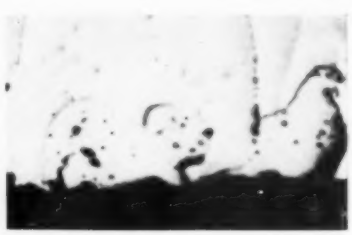
HAROLD LURIE
Metallurgist
Cummins Engine Co. Ltd.

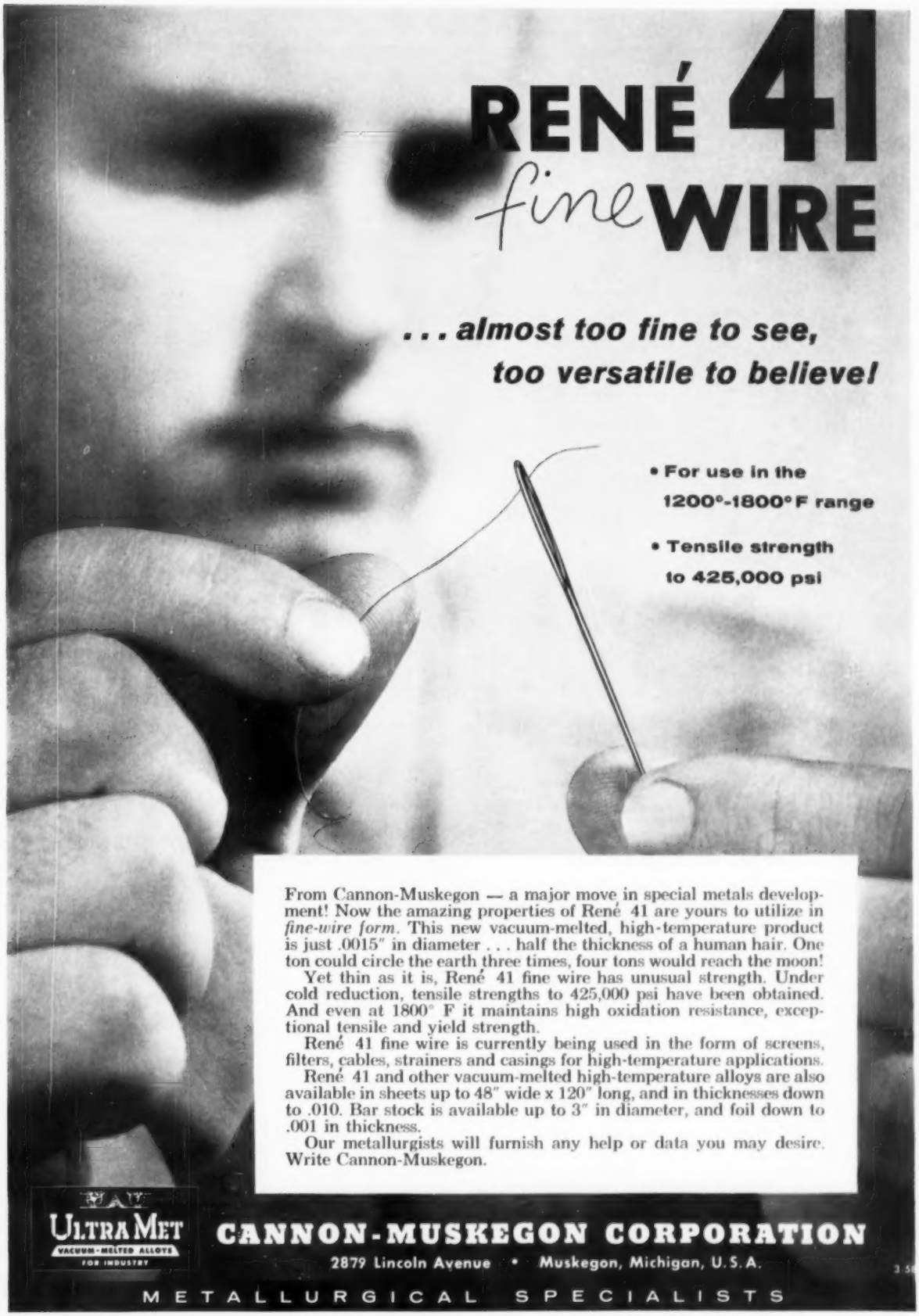
Barnyard Pals

WASHINGTON, D. C.

It is not unusual to find the outline of one animal in a photomicrograph, but in this there are two, a chicken and a very small puppy. The base material is Type 310 stainless steel that had been in contact with a $V_2O_5+NaVO_3$ mixture for 200 hr. at 1600° F. The specimen was etched electrolytically in 10% oxalic acid in water; magnification 750 ×.

JUNE CHUNG
Corrosion Section
Metallurgy Division
National Bureau of Standards

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too versatile to believe!
• For use in the 1200°-1800° F range
• Tensile strength to 425,000 psi
From Cannon-Muskegon — a major move in special metals development! Now the amazing properties of René 41 are yours to utilize in *fine-wire form*. This new vacuum-melted, high-temperature product is just .0015" in diameter . . . half the thickness of a human hair. One ton could circle the earth three times, four tons would reach the moon!
Yet thin as it is, René 41 fine wire has unusual strength. Under cold reduction, tensile strengths to 425,000 psi have been obtained. And even at 1800° F it maintains high oxidation resistance, exceptional tensile and yield strength.
René 41 fine wire is currently being used in the form of screens, filters, cables, strainers and casings for high-temperature applications.
René 41 and other vacuum-melted high-temperature alloys are also available in sheets up to 48" wide x 120" long, and in thicknesses down to .010. Bar stock is available up to 3" in diameter, and foil down to .001 in thickness.
Our metallurgists will furnish any help or data you may desire. Write Cannon-Muskegon.
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VACUUM-MELTED ALLOYS FOR INDUSTRY
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Contains a pre-heat furnace, a high-heat furnace and quench tanks in a unit designed for convenient positioning in your shop. Furnace sections are equipped with casters.

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Waltz small tool furnaces are "money makers" in many shops throughout the country. Enjoy the lucrative advantages of heat-treating facilities right in your own shop.

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Compacts of High Green Strength

WHITING, IND.

In the course of some studies at the Engineering Research Laboratories of Standard Oil Co. (Indiana), we made pellets of high-purity chromium carbides by the powder metallurgy method. These pellets were quite coherent and did not crumble readily even when they were crushed to a powder. Furthermore, they showed excellent resistance to oxidation by an air stream at 2500° F. This method could be used to make coherent metal carbide structures of intricate shapes and large sizes and possibly resistance parts for guided missiles.

The central idea is that a mixture of chromium and graphite, which is very well lubricated because of its high graphite content, can be compressed into intricate shapes readily. The mold material may be a relatively inexpensive material, such as brass, since the metal-graphite mixture is quite nonerosive. The compressed part has a reasonable green strength. The part then can be sintered directly into a carbide structure (Cr_4C, Cr_7C_3 or Cr_3C_2) by holding it in an inert atmosphere at temperatures as low as 2200° F. Apparently, the part will have a definite degree of porosity since there is only a small amount of shrinkage during sintering; it also will have a high degree of coherency. Conceivably, inserts of metal bars could be included to add to the strength of the sintered part.

C. F. TISINAI
Project Supervisor
Standard Oil Co. (Indiana)

1958 SOUTHWEST METAL CONGRESS BOOKS

Papers of Southwest Metal Congress in book form. All 8½ x 11 and paper bound. Titles are: High-Strength Steels for Aircraft (8 papers, 82 pages), Sheet Materials for High-Temperature Service (6 papers, 74 pages), New Fabrication Techniques (8 papers, 74 pages). All illustrated — $2.95 each — $8.00 per set of three. Clip and send to ASM Technical and Engineering Book Information Service, 7301 Euclid Ave., Cleveland 3, Ohio.

The Legendary Firebird, the Phoenix, rose young and strong again and again from flames . . . This is the new Norton Firebird — symbol for the exciting new fused materials made in Norton's electric furnaces.

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Roaring flames gave the legendary Phoenix the power to range over wide areas of earth, sea, and sky. Similarly, the white-hot fury of modern electric furnaces is Norton's source of power in making carbides of boron, silicon, titanium, and zirconium for an amazing range of applications.

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They have gained importance as rich chemical source materials . . . as metallurgical additives . . . as high temperature electrical conductors and resistors . . . and as refractories and cermet components.

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MAKING BETTER PRODUCTS . . . TO MAKE YOUR PRODUCTS BETTER

Personal Mention

Wolfgang H. Steurer

WOLFGANG H. STEURER, long associated with astronautics, particularly the material engineering aspects of the field, has joined Convair, a division of General Dynamics Corp. in San Diego, Calif., as chief of engineering materials.

Born in Freiburg, Germany, he studied at the University of Stuttgart, receiving a master's degree in mechanical engineering and a doctorate in metallurgy.

In 1941 he became assistant to the president of the Materials Testing Institute in Berlin, at the same time acting as secretary of the Board of Materials Testing Institutes. During the war years, he was appointed chief of the material testing laboratory in the German rocket development center at Peenemuende where the V-2 rocket was developed.

After the war, he accepted a contract with the U.S. Department of the Army and came to Fort Bliss, Tex., as part of a rocket development group. The group was transferred to Redstone Arsenal in Alabama in 1950 and Dr. Steurer was placed in charge of materials research in the newly established Army Ballistic Agency, where he has played a prominent part in the Army's missile program.

An American citizen since 1955, Dr. Steurer is well known to A.S.M. members throughout the country; over the past eight years he has talked before 15 A.S.M. chapters.

Glenn F. Whiteley has been appointed manager of the Bridgeport, Conn., plant of Heppenstall Co. Following his graduation from Pennsylvania State University in 1939, he joined the Bridgeport plant as a metallurgist. He became chief metallurgist a few years later and was transferred to Indianapolis when the company established its plant there and in 1958 was appointed manager of that plant.

K. H. Carlson is now technical manager of specialty steels in charge of technical development and service at Latrobe Steel Co., Latrobe, Pa. Mr. Carlson came to Latrobe from Carnegie-Illinois Steel Corp. as laboratory metallurgist.

John N. Ludwig, Jr., has joined International Nickel Co., Inc., New York, as supervisor of metallurgical services, with headquarters at the Pittsburgh office. He was formerly associated with the Electro Metallurgical Co., a division of Union Carbide Corp., for 21 years.

Paul M. Steiert is now engaged in metallographical and metallurgical work in the laboratories of Empire Reeves Steel Corp., Mansfield, Ohio. Formerly he was associated with the Mosow Screw Co. of Waukegan, Ill.

Gordon C. Williams has returned to his former position as head of the department of chemical engineering at the University of Louisville after a year's leave of absence as a participant in the E. I. du Pont de Nemours & Co. Inc. Year in Industry Program working in the engineering department.

James V. Peck, after his graduation from the University of Detroit with a bachelor's degree in chemical engineering, has joined the welding staff of the International Nickel Co. research laboratory.

J. R. Schettig, formerly an engineer in the Westinghouse Atomic Power Div., has joined Vanadium-Alloys Steel Co., Latrobe, Pa., as a research metallurgist.

George D. Haley, after receiving his master of science degree in metallurgy from the University of Illinois in 1957, was assigned to Wright-Patterson Air Force Base, Dayton, Ohio. He is currently working in the metals branch of the materials laboratory as project officer and, in addition, is studying toward a degree in business administration at the Ohio State University graduate center at the field.

Robert E. Lenhart recently joined the Beryllium Corp., Reading, Pa., as manager of alloy development. He was formerly with General Electric Co. in the power transformer department.

James K. Stanley and **James A. Stavrolakis** have been appointed section managers in technical development at the Crucible Steel Co. of America, Pittsburgh. Dr. Stanley was formerly supervisor of the silicon steel, magnetic materials and applied physics section in the company's central research laboratory while Dr. Stavrolakis was research coordinator.

Merle L. Gruver has been appointed superintendent of the soaking pits, blooming mill, slabbing mill and structural mill at Kaiser Steel Corp.'s Fontana, Calif., plant.

Robert G. Matters has been named to head the new materials engineering section of the steam turbine department of Allis-Chalmers Mfg. Co., Milwaukee, Wis. Matters has been concerned with steam turbine and generator metallurgical work for the company for 25 years, most recently serving as assistant director of research in charge of the materials service section.

M. J. O'Halloran has been appointed assistant general sales manager, industrial product sales, for Kaiser Aluminum & Chemical Sales, Inc., Chicago. Since joining Kaiser in 1950, he has been product manager and marketing manager of rod, bar and wire products.

Arnold T. Comyns has joined the staff of Speer Carbon Co., St. Marys, Pa. A member of the development-application section of the International Graphite & Electrode Div., he will be located at the Speer Research and Development Center at Niagara Falls, N. Y., following a period of training.

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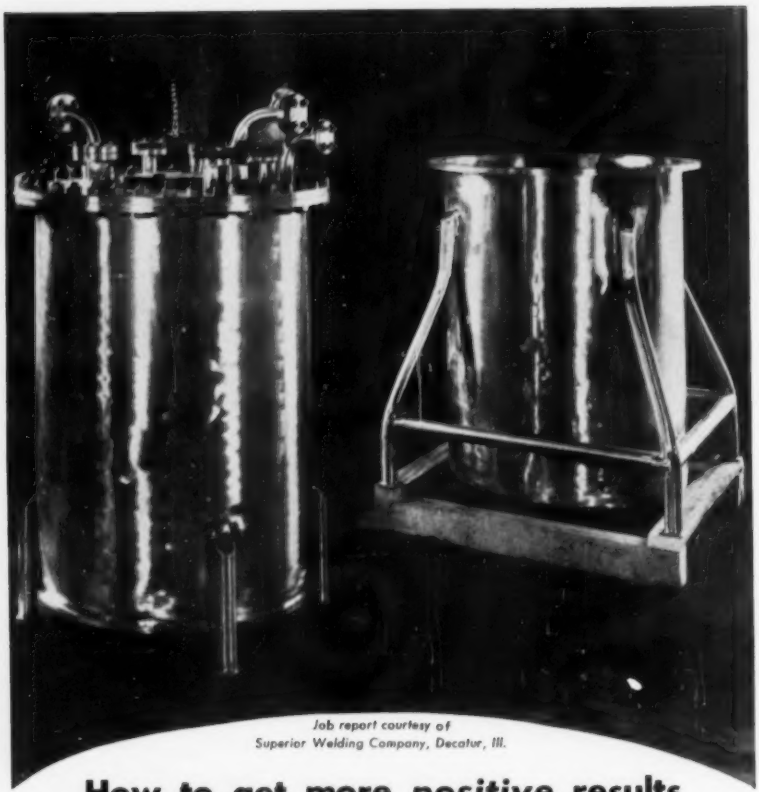

Job report courtesy of
Superior Welding Company, Decatur, Ill.

How to get more *positive* results when Welding Stainless

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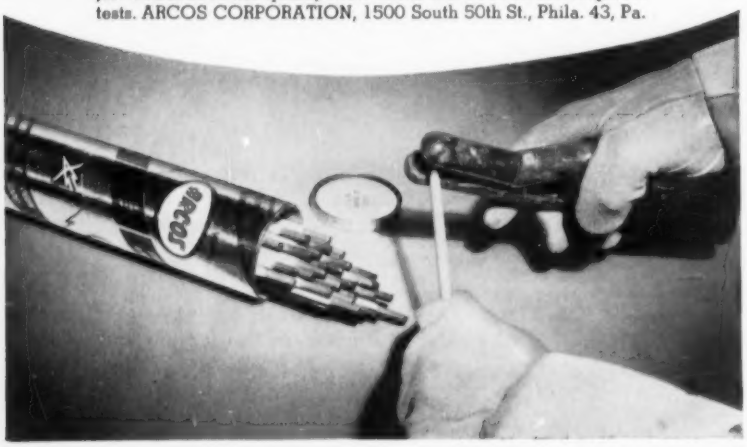
These vessels—used for processing a chemical where utmost product cleanliness is required—were made of 304 ELC Stainless Plate and welded with Arcos Chromend 19-9 CB (347) electrodes. The fabricator selected these electrodes for the "right" analysis to resist corrosion and to assure a surface, including the weld areas that would take a high polish both on the inside and outside to make thorough cleaning easy. It's proof again that whatever the job demands Arcos quality weld metal will meet all the required tests. ARCOS CORPORATION, 1500 South 50th St., Phila. 43, Pa.



Personals . . .

George N. Herrera has joined Southwest Oil Field Products as chief engineer in Houston, Tex. Prior to this assignment, he was senior engineer for McCullough Tool Co.

Joseph B. Darby, Jr., joined the metallurgical division of Argonne National Laboratory, Lemont, Ill., after receiving a Ph.D. degree in metallurgical engineering from the University of Illinois.

Kenneth Robert Kay has been promoted from his post as junior metallurgist at the Lacnor Mine to metallurgist at the Algom-Nordic Mine of Algom Uranium Mines Ltd., at Elliot Lake, Ont.

L. B. Gross is now employed as development engineer by Lycoming Div., Avco Mfg. Corp., Stratford, Conn.

Victor Little has resigned as plant superintendent of the Montreal, Ont., East Refinery of Canadian Copper Refineries Ltd. to enter the consulting field in copper refining and casting with offices in Metuchen, N.J.

T. Richardson has been transferred from a post as electrical engineer, Public Works Dept., U.S. Naval Air Station, Cubi Pt., Bataan, Philippines, to the installations engineer office, Clark Air Force Base, Philippines, as chief electrical and mechanical engineer.

Robert R. Sands, formerly affiliated with Reed Roller Bit Co. in Houston, Tex., is now a research engineer with Boeing Airplane Co. in Wichita, Kan.

Thomas A. Frischman, chief metallurgist in the axle division of Eaton Mfg. Co. for the past 22 years, has also been appointed chief of quality control. In his dual capacity as chief of metallurgy and quality control, he will continue to supervise the metallurgical activities of the Cleveland and Marion, Ohio, plants and have direct responsibility over quality and inspection.

John L. Cotsworth has been promoted to manager of warehouse sales for Chase Brass & Copper Co., Waterbury, Conn., retaining his responsibilities as product manager for stainless steel and aluminum.

Robert F. Cameron has accepted a position as metallurgical engineer with the American Chain and Cable Co., Inc., Monessen, Pa. For eight years he was plant metallurgist at the Buffalo, N.Y., plant of the Wickwire Spencer Steel Div., Colorado Fuel and Iron Corp.

William V. Youdelis, who recently received a doctorate in metallurgical engineering from McGill University, is now an assistant professor of metallurgy in the department of mining and metallurgy of the University of Alberta in Edmonton, Alberta.

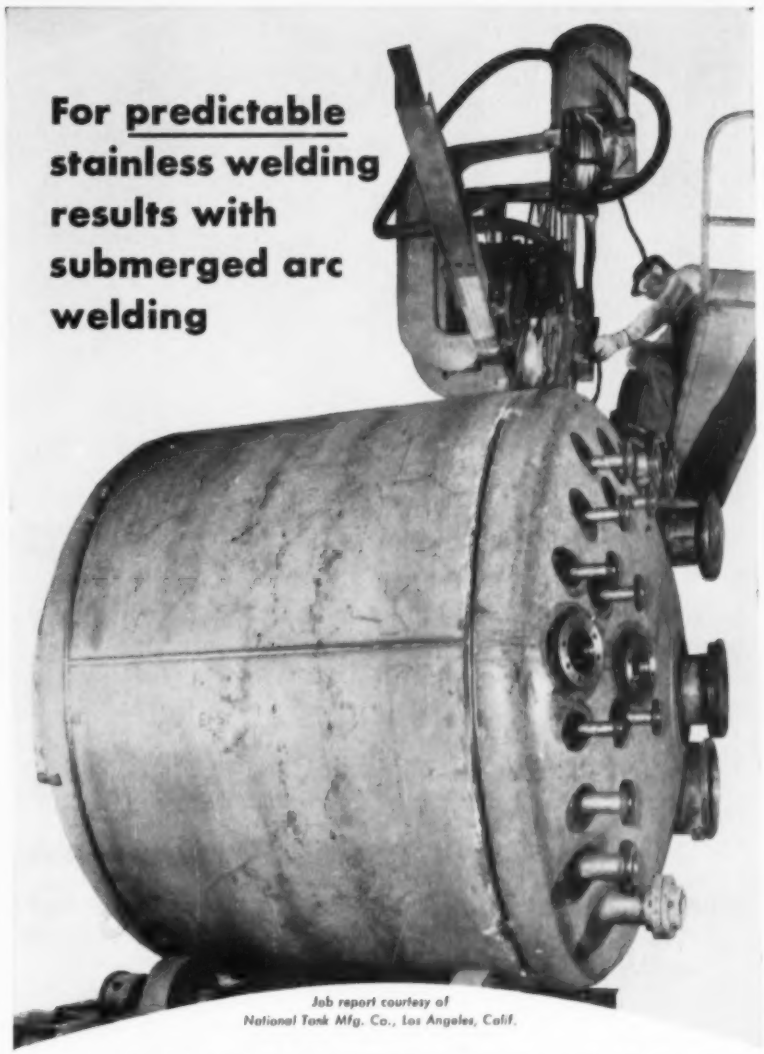
David E. Huber is currently metallurgical advisor to the production engineering department and a project engineer in the research and development program of Koontz-Wagner Electric Co., Inc., manufacturing division in South Bend, Ind.

F. N. Adgate is now manufacturing planner in welding and brazing for Rohr Aircraft Corp., Chula Vista, Calif.

Edward A. Renz has been appointed sales representative in the New York district sales office of Allegheny Ludlum Steel Corp., Pittsburgh. Prior to joining Allegheny Ludlum, he was affiliated with the Riverside-Alloy Metal Div. of H. K. Porter Co.

R. C. Lampert and **E. Paul Scott**, who joined Vanadium-Alloys Steel Co., Latrobe, Pa., after their graduation from college last June, have been assigned new jobs. Mr. Lampert, after a period of training in the service laboratory, is now a member of the product development group and will supervise metallurgy in the heat treating department. Mr. Scott has been transferred from the research laboratory, where he was working on special projects, to the metallurgical service staff as a service metallurgist.

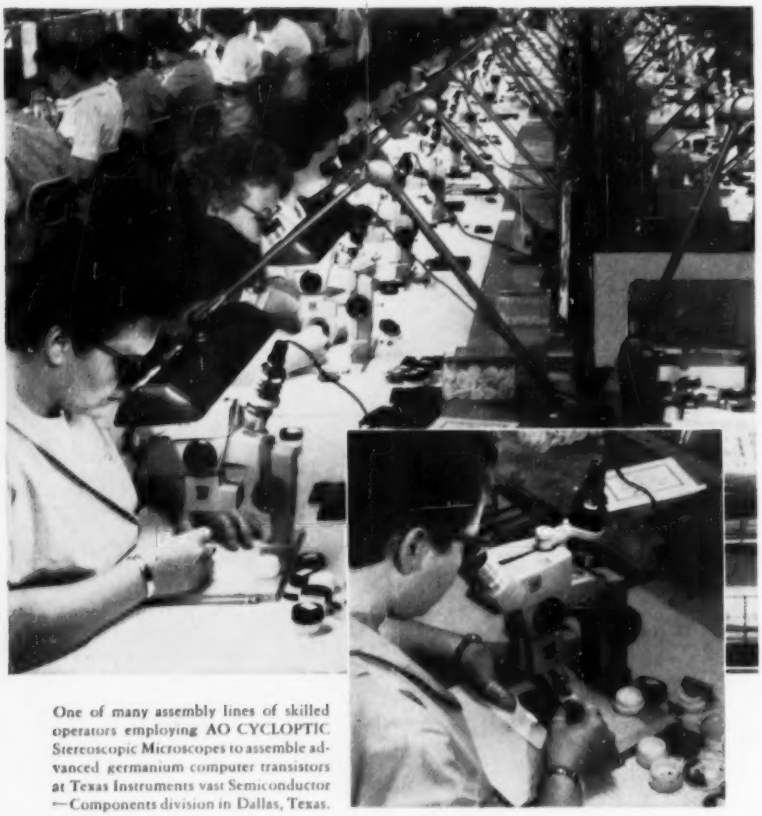
Allison Butts, professor emeritus of metallurgy at Lehigh University, has been named recipient of the Mineral Industry Education Award of the American Institute of Mining, Metallurgical, and Petroleum Engineers in recognition of "his notable role as a teacher and administrator, his many contributions to basic knowledge in metallurgy, his pioneer work in mineral economics . . ."



Job report courtesy of
National Tank Mfg. Co., Los Angeles, Calif.

use ARCOSITE BONDED FLUX

This 4,000-gallon tank for a resin reactor will handle highly corrosive material at temperatures of 500° to 600°F. Stainless top and bottom heads of type 316L were submerged arc welded to the body with Arcosite Flux and Arcos Chromenar Stainless Wire. This combination gives the proper weld metal chemistry for the needed corrosion resistance and an economical solution to the problem. ARCOS CORPORATION, 1500 S. 50th Street, Philadelphia 43, Penna.



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When manufacturing small precision assemblies... many progressive companies such as TI, depend upon the AO CYCLOPTIC to render the unit in visual "working size" dimensions.

If you have a particular production situation that 3-D magnification would help, why not discuss it with a capable AO Sales Representative. He can recommend the AO CYCLOPTIC Stereoscopic Microscope that will certainly solve your individual problem. There is no obligation, of course.

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☐ Please send AO CYCLOPTIC Brochure SB56.

NAME_____

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Personals . . .

Charles F. Benner has been named manager of experimental production for Continental Can Co.'s metal division research and development. A member of Continental's metallurgical staff since 1950, he was supervisor of metallurgical engineering metal research and development until his new assignment.

E. P. Best, a member of the company for 42 years, has been appointed director of metallurgy and research and **T. D. Bonner** named chief wrought iron metallurgist for A. M. Byers Co., Pittsburgh. Formerly chief metallurgist, Mr. Best now heads Byers metallurgical, chemical and research departments.

Childress B. Gwyn, Jr., has been named special projects engineer, responsible for technical liaison with engineering, manufacturing and sales for Gibson Electric Co., Delmont, Pa.

Ernest G. Farrier, formerly connected with the University of Alabama, has become a member of the staff of the gaseous diffusion plant of the Union Carbide Nuclear Co., a division of Union Carbide Corp., Oak Ridge, Tenn.

Samuel A. Ott has been elected vice-president in charge of operations, eastern division of the Colorado Fuel and Iron Corp. Mr. Ott joined CF&I in January 1956 as works manager of the Claymount division.

R. L. Harper, executive vice-president of Harper Electric Furnace Corp., Buffalo, N. Y., has been elected president of the Industrial Heating Equipment Assoc. and **W. E. Benninghoff**, vice-president and Tocco Div. manager, Ohio Crankshaft Co., Cleveland, elected vice-president.

Michael Tenenbaum has been named assistant general manager of technical services for Inland Steel Co.'s Indiana Harbor Works in East Chicago, Ind., where he will head the departments dealing with quality control, production control and industrial engineering. He was formerly superintendent of the metallurgical department.

From left to right, Mr. Karl Woerle, Foreman, Mr Neil Paterson, Supervisor of Tools and Equipment, Mr. Robert Settles, Park Chemical Company Representative

Hamilton Standard gets better results from Park Aluminum Brazing Salt

In many cases, dip brazing in salt baths is the most practical method of joining aluminum. Extremely thin gage aluminum can be handled without damage from pitting or distortion because of uniform heating, close temperature control and the buoyancy of the molten bath. Salt brazing is often the only way complicated assemblies such as heat exchangers can be brazed successfully.

Park Aluminum Brazing Salts are superior to other fluxes because of their better fluidity, greater stability, freedom from sludge and ease of cleaning. They act as both flux and heat transfer medium for all dip brazing operations on aluminum alloys. Joints can be made by using wire rings, flat shims or brazing sheet. Assemblies of various sizes and shapes can be brazed at the same time, saving time and labor.

Hamilton Standard's work includes a variety of aircraft parts requiring a high quality bond. It is important that an aluminum brazing salt be used that meets their high standards of quality. Park Aluminum Brazing Salt D has produced quality brazing efficiently and economically for Hamilton Standard. Separate additions of costly chlorides have been eliminated. Laboratory and maintenance control has been reduced to a minimum. The problem of desludging three times a week has been reduced to checking for sludge once a week. The stability and reliability of Park Aluminum Brazing Salt has been amply demonstrated.

For detailed information on Park Aluminum Brazing Salts and their applications, send for technical bulletins or contact your nearest Park representative.

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Write for Catalog RT-58. It gives complete details on the full line of Wilson hardness testing equipment.

Wilson "Brale" Diamond Penetrators give Perfect Readings

A perfect diamond penetrator is essential to accurate testing. Only flawless diamonds are used with Wilson "Brale" penetrators. Each diamond is cut to an exact shape. Microscopic inspection and a comparator check of each diamond—one by one—assure you of accurate hardness testing every time.

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Personals . . .

Luther F. Taylor and **Samuel H. Cole** have been assigned new positions in the sales department of Superior Steel Div. of Copperweld Steel Co., Carnegie, Pa. Mr. Luther has been promoted from assistant general manager of sales to manager of sales development, and Mr. Cole has assumed the responsibilities of manager of stainless steel sales.

J. Lester Klein has been elected vice-president of Nuclear Metals, Inc., Concord, Mass. Prior to this appointment, he was manager of the new developments division and assistant technical director.

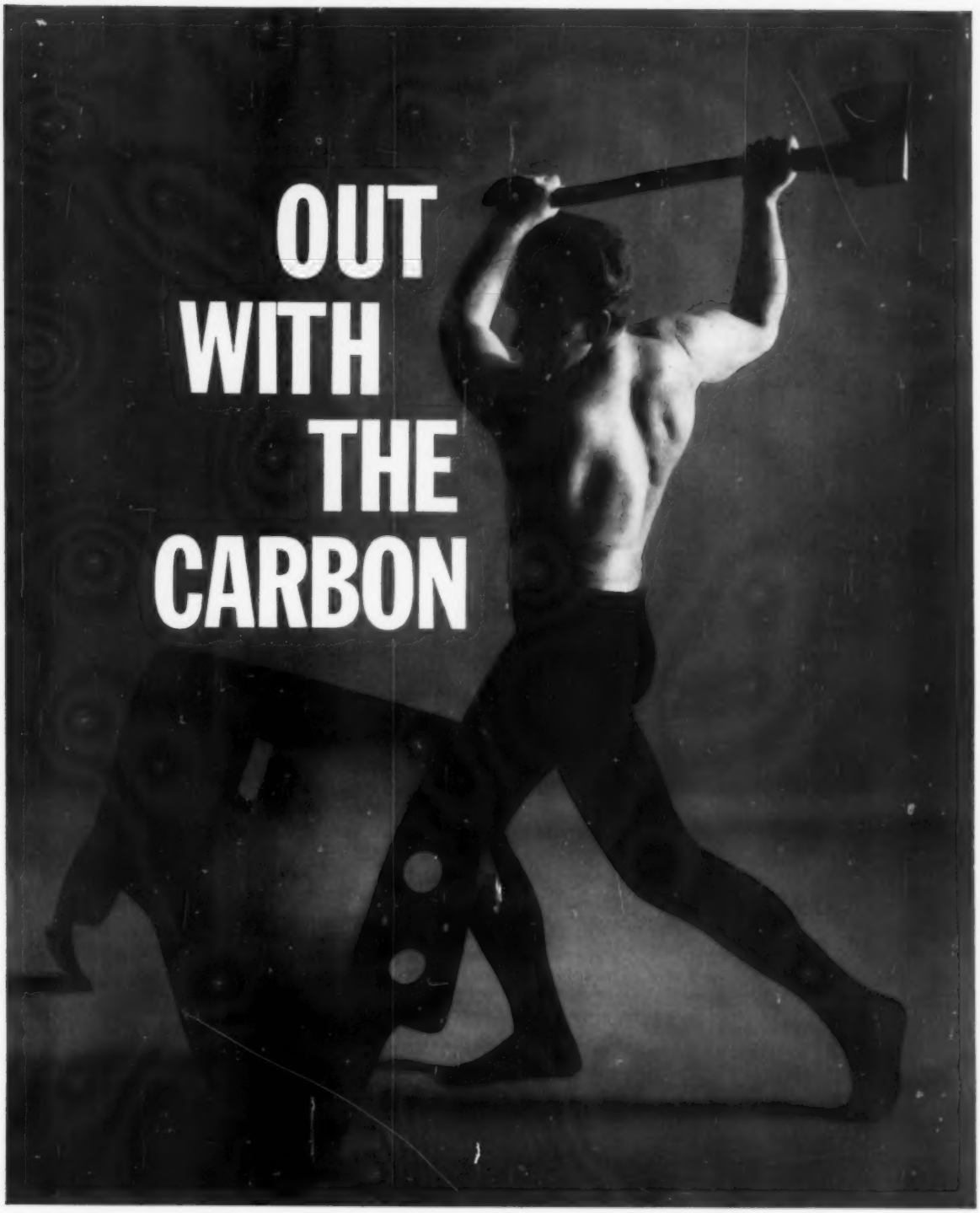
Roy M. Laning has retired as assistant district sales manager at the Jones & Laughlin Steel Corp. district sales office in Detroit. An employee of the company since 1932, he was assigned to the Detroit office in 1944 and in 1951 promoted to his current position.

Th. Andresen has resigned his position as development engineer with the alloys and metals department of Union Carbide International Co., New York, to join Premium Iron Ores Ltd. in Montreal, Quebec, as a metallurgical engineer.

Samuel Storchheim has left Metals Research and Development Inc. to open his own laboratory, Storchheim Research & Development Corp. in Woodside, N.Y., specializing in new materials, processes and products primarily in the powder metallurgy area.

Carl W. Shattuck, formerly first vice-president of McKiernan-Terry Corp., Harrison, N. J., has been elected president of the organization. He has been connected with the corporation for 30 years, and was previously in charge of the Dover, N. J., plant.

John Chipman, professor of metallurgy at Massachusetts Institute of Technology, has been elected president of the Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers, succeeding **Walter R. Hibbard, Jr.**, manager, alloy studies research, General Electric Co. Research Laboratory, who has become a vice-president of A.I.M.E.



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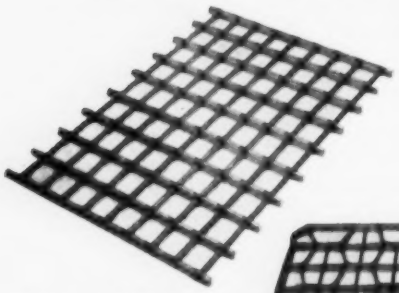

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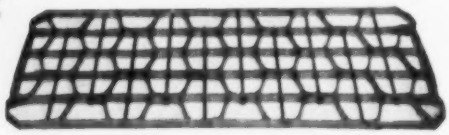
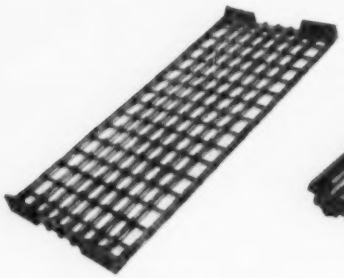
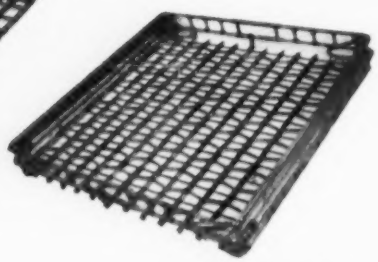


"Serpentine"



**"Pressure Welded"
with pusher pads**



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Not only can Rolock design and construction reduce tray weight (often by 25% to 50%) and thus increase pay-load, but service records frequently show that tray life has doubled or tripled.

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IRL59

Personals . . .

D. W. White has taken a leave of absence from General Electric Co. to accept an assignment as metallurgical consultant and chief of the metallurgy department of the Centre d'Etudes de l'Energie Nucleaire in Belgium, with headquarters at the C.E.N. laboratory in Mol, near Brussels, Belgium.

H. J. Siekmann has been promoted to manager, market development and research, in the metallurgical products department of General Electric Co., Detroit. He formerly was manager of applied mechanics engineering.

Robert D. Failor has been assigned as manager of the Salt Lake City, Utah, office of Leeds & Northrup Co., Philadelphia. Affiliated with Leeds & Northrup since 1949, he was field engineer in San Francisco until his recent promotion.

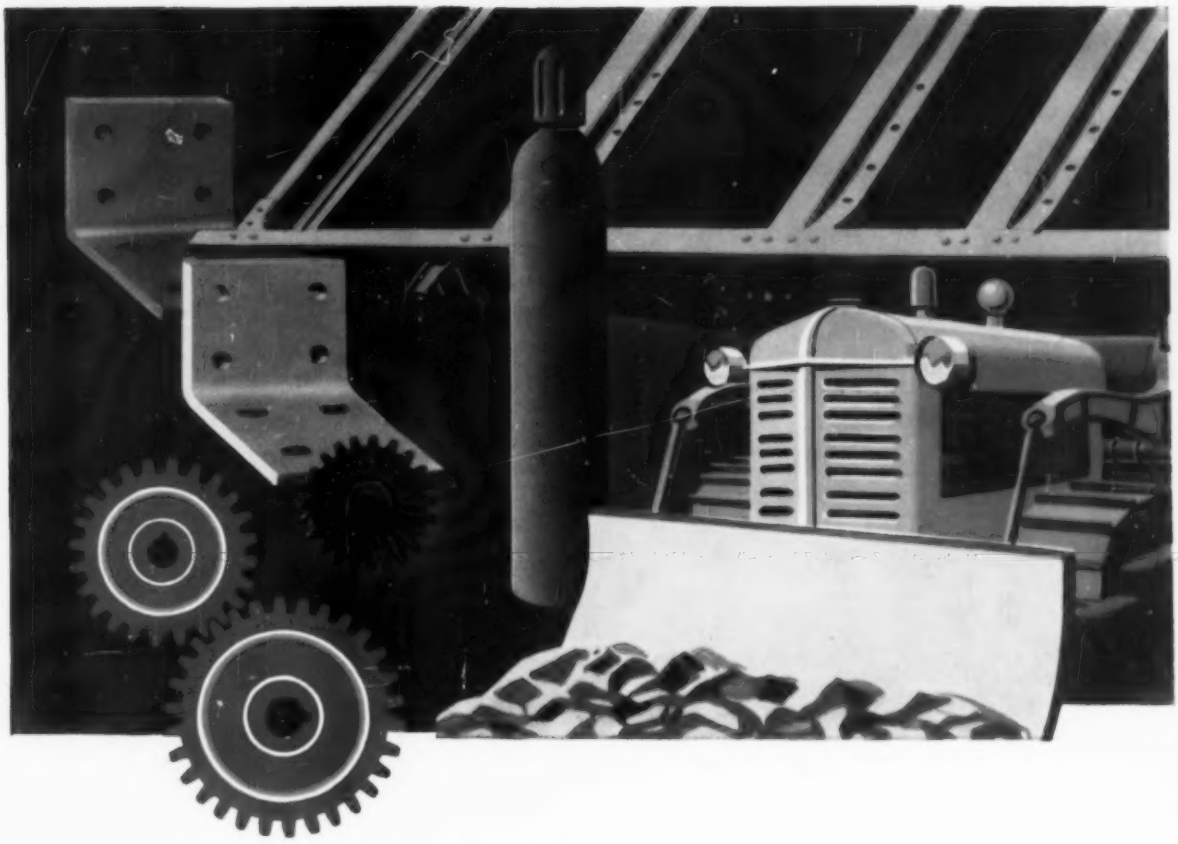
James D. Glenn II has been appointed to the newly created position of staff assistant in the titanium and vacuum metals sales division of Crucible Steel Co., of America, with headquarters at Pittsburgh.

Aaron Wachter, director of research, Shell Development Corp., Emeryville, Calif., has been awarded the 1958 Frank Newman Speller Award for his achievements in corrosion engineering by the National Assoc. of Corrosion Engineers.

L. L. Werner, recently named executive vice-president of R. D. Werner Co., Inc., has announced the promotion of **R. L. Werner**, assistant chief engineer, to chief engineer at the company's Plant No. 1 in Greenville, Pa.

Gerald C. Gardner has been promoted to the newly created position of assistant supervisor, flat rolled products, in the sales technical services organization of Jones & Laughlin Steel Corp., Pittsburgh.

Arthur R. Matheson has been appointed manager, reprocessing, at Sylvania-Corning Nuclear Corp.'s Bayside, L. I., N. Y., facility, where he will be responsible for reprocessing spent fuel elements from nuclear reactors. Prior to joining Sylcor, he was associated with M & C Nuclear, Inc., Attleboro, Mass.



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Columbium for your use?"

Many engineers are taking advantage of the special properties which columbium imparts to steel, at a production cost which is most favorable. Properties obtained in the as-rolled condition afford such advantages as finer internal grain structure, higher yield strength, excellent weldability and increased toughness.

MCA has been actively engaged in the pioneering development and use of columbium in open hearth and electric furnace applications with a number of major steel producers. These steel companies are currently evaluating manufacturing methods in the use of columbium steel production. A broad range of application for these steels includes pressure cylinders, earth-moving equipment, truck frames, automotive brackets and gears and many other tough duty uses in the construction and transportation categories.

MCA welcomes the opportunity of working with your production and engineering personnel in the development of columbium in treating steels.

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Metals Engineering Digest

. . . Interpretative Reports of World-Wide Developments

Vacuum Melting Stainless Steels and Superalloys

Digest of "Quality Improvements in Stainless Steels and Superalloys by Vacuum Melting", by W. W. Dyrkacz, Allegheny Ludlum Steel Corp., Watervliet, N. Y. Paper presented at Western Metal Congress, Los Angeles, March 1959.

TWO VACUUM MELTING processes which have reached production status are (*a*) induction, and (*b*) consumable-electrode arc melting under vacuum or in protective atmosphere. The induction method consists of melting in a vacuum chamber using a conventional induction furnace with a zirconia or magnesia crucible. The consumable-electrode remelting process, as practiced today, uses air-melted electrodes of a predetermined composition and consumably remelts them in a copper, water cooled crucible under vacuum or argon. Generally, vacuum is employed; exceptions are certain nitrogen-bearing stainless steels which are melted in an argon atmosphere. Alloys being produced by vacuum melting include:

1. Low-alloy steels – S.A.E. 9310, 4140, 4340, 6150, 300-M.
2. Bearing steels – S.A.E. 52100, MHT.
3. Stainless steels – 403, 431, 440 C, 304, 321, AM-355.
4. Tool and die steels.
5. Iron-base, high-aluminum alloys.
6. Nickel-base and cobalt-base magnetic and electrical alloys.
7. Superalloys – A-286, Discaloy, M-252, Waspaloy, Super Waspaloy, René 41, M-308, D-979, Inco 901, Udimet 500, GMR-235.

Quality Aspects – Quality improvements possible with vacuum melting over air melting fall into seven major categories: (*a*) decreased gas content; (*b*) improved cleanliness; (*c*) better hot and cold workability; (*d*) higher mechanical properties; (*e*) improved magnetic properties; (*f*) improved soundness; (*g*) production of new metals and alloys which cannot be melted and hot worked economically or with any degree of predictability of yields and quality by conventional methods now in use.

These quality improvements can be obtained in some alloys by induction melting, in other instances by consumable electrode melting only. With some alloys, optimum quality is obtained by combining the two processes. The extent of these quality improvements depends on the ability to control melting and solidification variables.

The induction process gives greater improvement in mechanical properties where these improvements are chemistry-sensitive. On the other hand, consumable-electrode melting is superior on these counts: (*a*) improved mechanical properties, which are segregation or structure-sensitive, (*b*) improved soundness, particularly in large billet cross-sections, and (*c*) lower cost. (*Continued on p.* 140)

Table I – Approximate Range of Gas Contents in Final Product

Melting Process	Hydrogen		Oxygen		Nitrogen	
	Low-Alloy†	Stainless‡	Low-Alloy†	Stainless‡	Low-Alloy†	Stainless‡
Air melt under slag*	1-20 ppm.	5-15 ppm.	50-125 ppm.	10-200 ppm.	30-500 ppm.	50-600 ppm.
Vacuum melt, induction	<1	<1-2	5-15	5-125	5-50	20-200
Vacuum melt, consumable-electrode arc	<1-2	<1-2	5-25	10-100	10-100	20-200

*Basic electric arc. †0.25% C (killed). ‡Or high-temperature alloy (Fe, Ni or Co-base).

To keep immersion heating jobs moving . . .

Come to Kemp

Thirty-two ton Kemp Immersion Melting Pot keeps production on a 24 hour basis at Stanley Works, New Britain, Conn. Steel strapping is annealed on a continuous basis with important savings in time and fuel costs.

Where speed plus a high degree of control counts, depend on Kemp Immersion Heating Units. Kemp units give you sensitive and accurate control of heating needs for annealing, tempering, melting soft metals, and in many other applications.

Unique Kemp design puts the heat where it belongs . . . next to the material being heated. It goes to work immediately, without wasting time heating heavy pots, practically eliminates overrun and lag. The Kemp Industrial Carburetor, the basis for Kemp engineering design, premixes fuel gas and air to optimum ignition conditions. You get a cleaner operation with appreciable savings on fuel costs.

This kind of efficiency pays off with a better finished product at lower cost. You can forget about delays, cracked pots, exposed flame, and wasted down time. With Kemp Immersion Heating Unit at work for you, you can expect the finest performance of its kind—the result of a quarter century's pioneering experience.

Capacities from 1 to 75 tons—melting rates up to 26 tons per hour. For more information and practical suggestions, call in your Kemp Representative or write us direct for Bulletin IE-11. *The C. M. Kemp Mfg. Co.*, 405 E. Oliver St., Baltimore 2, Md.

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"Accurate control assures continuous bright copper brazing" —*reports Amphenol*

Amphenol Electronics Corporation, Chicago, uses this Hevi-Duty furnace for brazing copper to electronic components at 2050° F. Components move on a variable speed conveyor through two heating zones in a rich 6-to-1 exothermic atmosphere.

Atmosphere is supplied to the furnace by a Hevi-Duty Gas Preparation Unit. The correct mixture of gas is controlled by a single, simple adjustment and maintained automatically regardless of volume desired.

Excellent control of temperature, as well as atmosphere, helps maintain the bright, clean finish characteristic of Amphenol products, and demonstrates once again that *it takes quality to make quality.*

For complete information on Hevi-Duty Mesh Belt Conveyor Furnaces, write for Bulletin 357.

- Heat Processing Furnaces
- Dry Type Transformers
- Constant Current Regulators

HEVI-DUTY ELECTRIC CO.
Milwaukee 1, Wisconsin

Vacuum Melting . . .

Quality Improvements – Vacuum melting reduces the gas content over air melting. Table I compares the vacuum melted gas level of low-alloy steels, stainless steels, and superalloys with the gas level of these materials when made by the basic electric arc process. Gas levels of both induction and consumable-electrode remelted alloys are of about the same order of magnitude.

Vacuum melting improves cleanliness. Experience with some alloys has shown that the quality variation from heat to heat (cleanliness scatterband) is less with arc remelted than with induction vacuum melted material because of the possibility of refractory contamination in the latter process. Cleanliness is most frequently evaluated by magnetic particle inspection or seam counts at 1 ×, and by metallographic examination at 100 ×.

Upset Test – A standard test for evaluating hot workability is the upset test. Materials which contain excessive subsurface inclusions of the stringer type crack very severely on the periphery when hot upset. Figure 1 shows how well this mill test correlates with manufacturing results obtained in producing cold

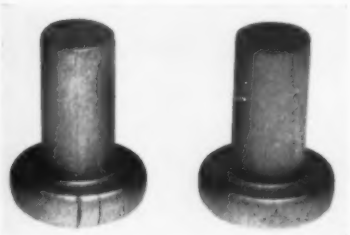


Fig. 1 – Improved Workability of Consumable-Electrode Vacuum Melted Material (Right) Compared With Air Melt (Left) Is Demonstrated by These Cold-Headed Bolts of A-286

headed bolts made from air melted and vacuum melted A-286 alloy. Previous to vacuum melting, hot workability rejection rates were quite high because of the difficulty of producing a clean material by air melting. Improvements in cleanliness also give improved cold workability in processes such as shear forming, flow-turning, or hydrospinning, where air melted material

would tend to tear along the stringers or in areas having a concentration of inclusions.

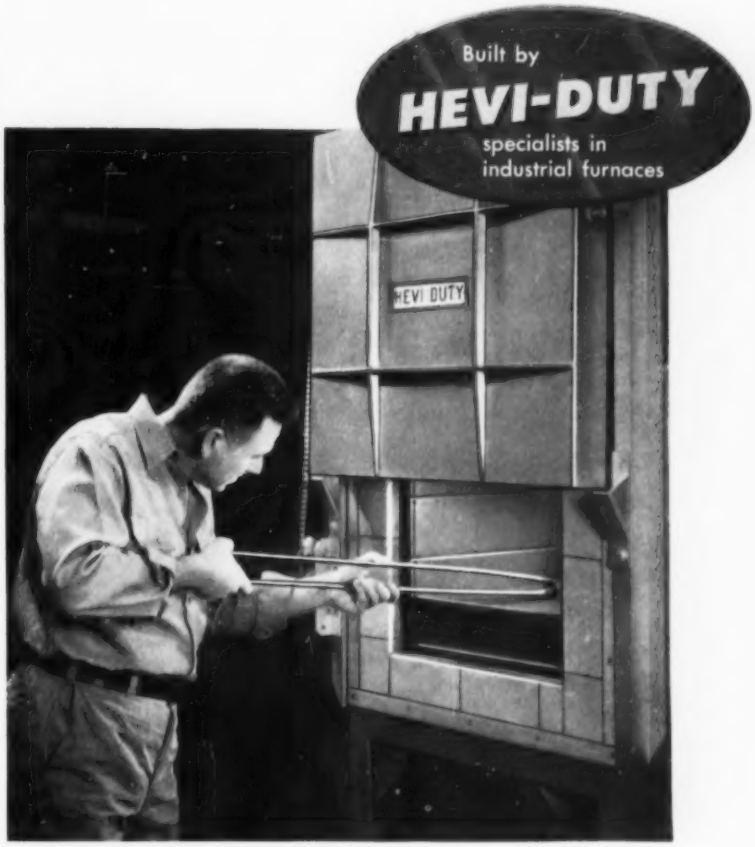
Higher Mechanical Properties – Here property improvements can be divided into three categories – those which are cleanliness-sensitive, chemistry-sensitive, and segregation-sensitive.

An example of a cleanliness-sensitive property is room-temperature fatigue strength. It is generally felt that improvement in fatigue strength from vacuum processing is due to elimination of gross inclusions which act as stress-raisers. A property which is chemistry-sensitive is stress-rupture life. Improvement here is due to ability to melt to higher and more closely controlled titanium and aluminum contents. Titanium and aluminum in most superalloys can be controlled within $\pm$ 0.12%. This compares with practical limits of $\pm$ 0.25% in air melting. Techniques are being developed to allow the addition of small quantities of reactive elements in the vacuum arc furnace which will result in a narrowing of the stress-rupture life scatterband for alloys produced by this vacuum process.

Another example of chemistry-sensitivity, which came to light through close control made possible by induction vacuum melting, was the profound effect of small quantities of impurity elements. It was found that trace amounts of boron and zirconium increased both the stress-rupture life and elongation of Super Waspaloy. Narrow boron ranges, for example 0.003 to 0.010%, do not pose any control problems during air melting. However, zirconium does present problems.

Segregation – Many alloys, particularly those which contain appreciable amounts of high-density elements, are segregation-sensitive. This is minimized or eliminated by consumable-electrode vacuum melting, because of rapid cooling in the copper, water cooled mold. Prior to consumable-electrode melting, it was impossible to produce large billet sections to ultrasonic specifications with any predictability of quality and yields.

Elimination of segregation improves transverse ductility in superalloys A-286 and N-155. In the new precipitation hardening stainless steel, AM-355, improvements in tensile and yield strengths, as well as



Temperite® furnace keeps an eye on steel quality for Universal Cyclops

This Hevi-Duty Temperite furnace plays an important part in quality control at Universal Cyclops Company, Bridgeville, Pennsylvania. It is used in the laboratory for aging high-temperature alloys and for tempering tool steel.

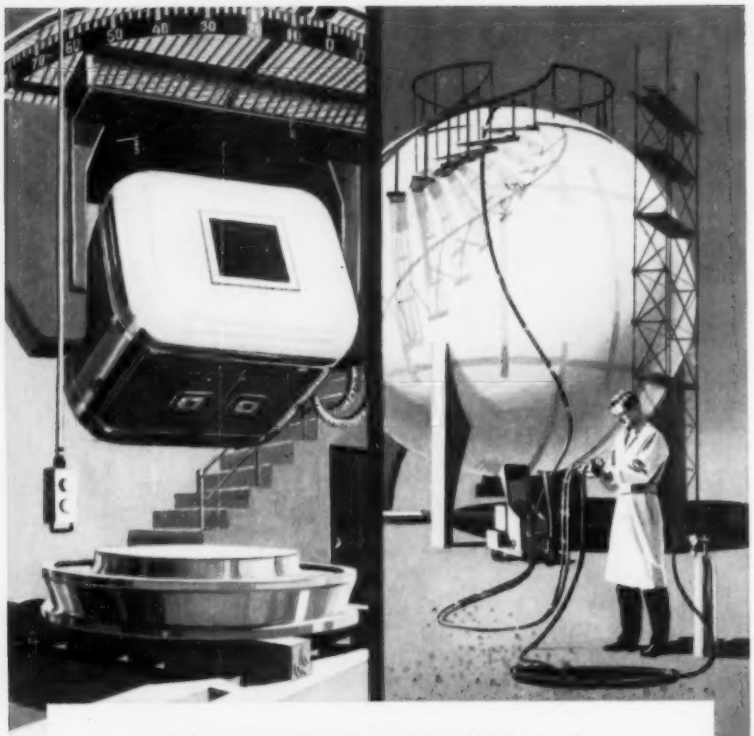
Samples of plate, sheet and bar stock up to 24 inches long are selected at random from the mill production and spot-checked to make sure rigid specifications are met. High-temperature alloys are aged at 1325°F., and tool steels are tempered up to 1100°F.

R. D. Williams, the supervising metallurgist, says that the large capacity and excellent temperature uniformity of the Temperite furnace make possible extremely accurate tests of large batches of samples. He also appreciates the fact that it has required no servicing despite its being used 24 hours a day.

For further details on the Hevi-Duty Temperite furnace, write for Bulletin 355.

- Industrial Furnaces electric and fuel
- Dry Type Transformers
- Constant Current Regulators

HEVI-DUTY ELECTRIC CO.
Milwaukee 1, Wisconsin



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Vacuum Melting . . .

in ductility, are achieved through elimination of grossly segregated free ferrite or retained austenite.

In superalloys, such as A-286, D-979 and Waspaloy, which depend upon the Ni_3Ti or $Ni_3(TiAl)$ constituents for their precipitation hardened strength, it is important that titanium segregation be held to a minimum. In large, conventionally cast ingots of alloys of this type, titanium variations of as much as 0.40% have often been found throughout the length and cross section of the ingot. Titanium variations in ingots melted by the consumable-electrode process generally run about 0.15%.

Improved Magnetic Properties – Recent work has shown that impurities have a profound effect on magnetic properties. Induction vacuum melted Supermendur (49 Fe, 49 Co, 2 V) has the highest remanence and highest permeability associated with the highest flux density of any magnetic material.

Improved Soundness – There are no problems in producing sound ingots by both vacuum processes in small sizes. However, once ingot sizes large enough to produce large slabs or billets (over 10 in. square in cross section) are required, difficulty is encountered in meeting the rigid ultrasonic inspection requirements with induction materials. The consumable-electrode process is predicated on incremental melting and solidification; therefore, it is ideal for close control of solidification variables. Rejections of finished parts of large cross sections, such as turbine wheel forgings, have been reduced drastically with consumable-electrode melted billets.

New Alloys – Both vacuum melting processes have given birth to a new series of high-temperature alloys, such as Udimet 500, M-308, D-979, René 41, and Super Waspaloy. Iron and nickel-base alloys of this type containing a combined total of titanium and aluminum of about 3 to 6% could not be produced consistently by the air melting process.

Combined Processing – In superalloys, very high quality can be obtained by using induction vacuum melting for close chemistry control to improve stress-rupture life. The

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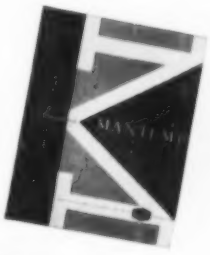
An almost foolproof way to hit open-hearth manganese specifications consistently is with ladle additions of MANTEMP ferromanganese. Mill superintendents have reported that the alloy yields high recoveries and allows substantial reductions in overall ingot costs.

Fine grain size specifications can also be met easily because MANTEMP ferromanganese does not preferentially oxidize separately added aluminum. The alloy is available in both high- and medium-carbon grades, packed in cans containing exactly 40 pounds of manganese.

UNION CARBIDE METALS COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

For further information, write for this new six-page MANTEMP ferromanganese bulletin.



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Vacuum Melting . . .

heat is tapped into electrode form, and then remelted by the consumable-electrode vacuum process to get good center ductility, a high degree of soundness, and the least amount of segregation. Combining the two processes also results in higher cost for the alloys.

As a general rule, consumable-electrode melted alloys are cheaper than induction vacuum melted materials especially in stainless and low-alloy steels.

A.G.G.

Investment Castings

Digest of papers presented at a meeting of the Investment Casting Institute, Muskegon, Mich., June 24-25, 1958.

"Casting Design for the Ultimate in Load Carrying Ability," by John B. Caine, Technical Consultant, Cincinnati, Ohio — Some design authorities now say that a properly designed casting is the strongest part that can be made out of a given metal, having a given hardness, providing that it is correctly founded. The foundryman must eliminate tensile property criteria in his evaluation of strength of cast metals; he cannot compete with wrought metal until he does. Over-evaluation of wrought metals is much more dangerous to the user than the tension test's under-evaluation of cast metals. The load-carrying ability is influenced more by the shape imposed by design, than by the metal itself.

When a part made of ductile metal is subjected to dynamic loading and is not uniform in cross section, the property limiting the load-carrying ability is not tensile or yield strength, but fatigue strength. Fatigue strength in turn is primarily dependent on stress concentration. These relations are general and apply to any material formed in any way. For a brittle material, stress concentration becomes the major factor, not only in dynamic loading but also under static loads. Streamlining and castability are both design essentials; thus the designer should have a rudimentary knowledge of the casting process. Also, the foundryman should understand basic design factors. The foregoing applies especially to simple shapes. In the past the foundry has concentrated its business on complex shapes, but by competing in the manufacture of simple shapes as well, it should greatly enlarge its scope. This will only come about by close cooperation of designer and foundryman *before* the drawings are handed to the patternmaker.

At present the foundryman can offer the designer only some rather nebulous cast shapes that may or may not be suitable. He can offer no quantitative data on the load-carrying ability of these shapes. The designer has, therefore, to either calculate the design properties of one of the shapes now recommended for casting, or refer to published tables for these same properties in a rolled shape. The foundryman must develop standard shapes having properties equal to or better than the standard rolled ones, if he is to compete successfully.

"The Fundamental Aspects of Ceramic Shells in Precision Casting", by Karl Scheffer, General Electric Co., Schenectady, N.Y. — Mr. Scheffer believes that certain shapes can be made more easily, more

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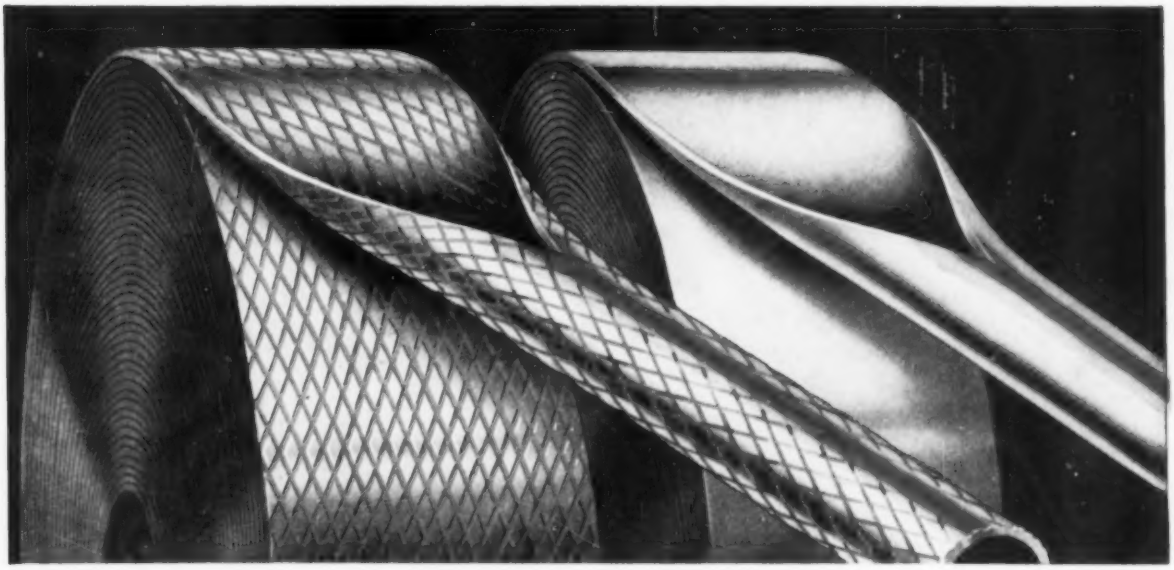

Quaker State Metals Company, leading fabricator of aluminum building products, recently installed a 25 kw, 450,000 cycle TOCCOtron vacuum tube oscillator for continuous welding of aluminum tubing. Both plain and patterned strip, anodized or untreated according to end-use requirements, is continuously welded. Diameters vary from ½" to 1" O. D. and wall thicknesses from .024 to .064".

The weld is absolutely uniform throughout the entire length, assuring a dependable, strong bond. The whole operation is so smooth and quiet, you hardly know it's running.

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Remember, whether *your* products are of ferrous or non-ferrous metals, TOCCO can almost certainly save *you* time and money in heat-treating, brazing, welding, or hot forming operations.

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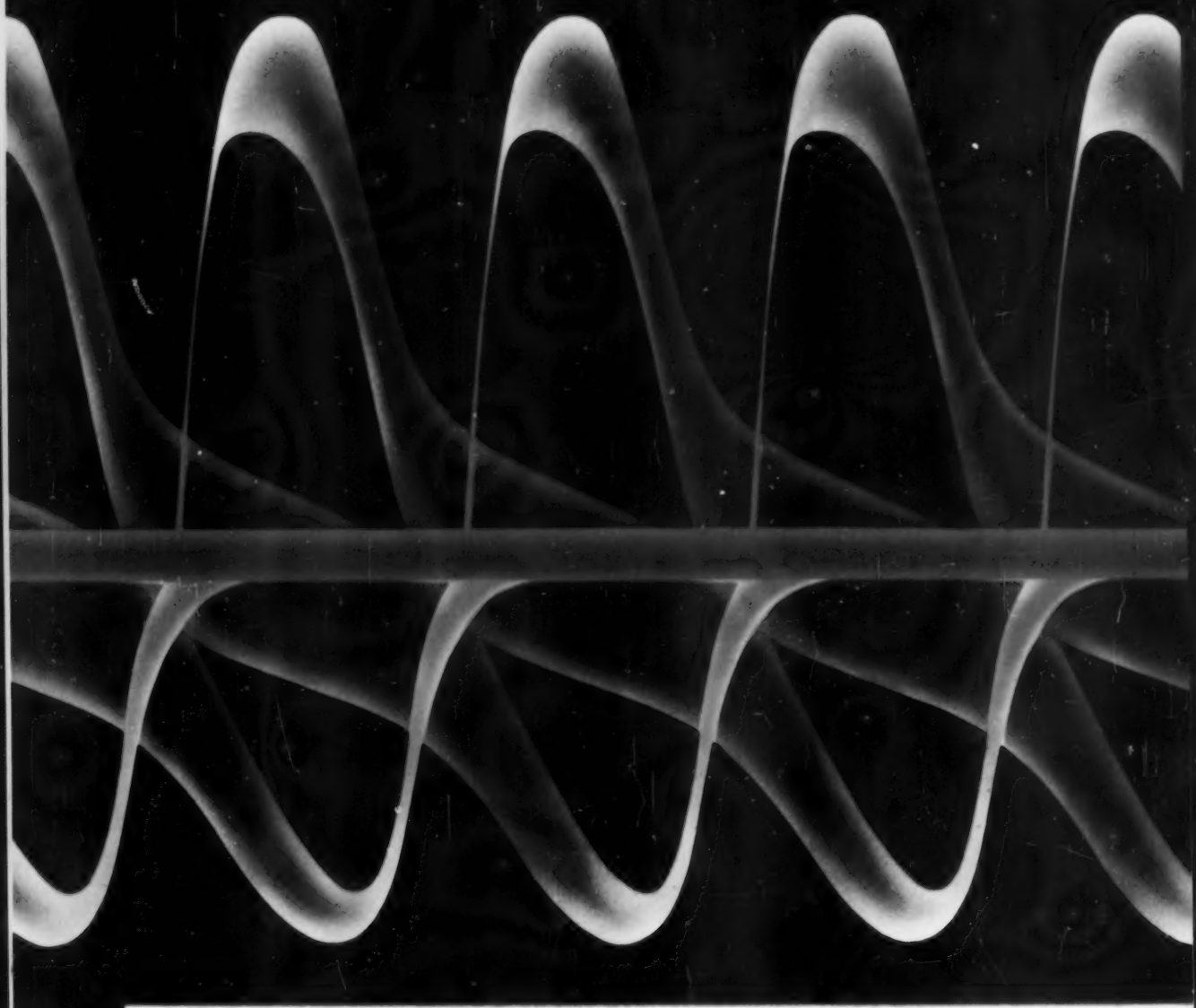


The cathode ray oscilloscope is one of science's and industry's most perceptive instruments for determining uniformity of operation. The pattern reproduced here is a harmonically modulated sine wave of exact uniformity.

Uniformity is Malleable

Just as the input of an oscilloscope can be controlled to produce repetitive patterns, so can consistently uniform metal parts be produced with Malleable iron because of modern, scientific controls. The unique method by which all Malleable castings are made and the exacting techniques employed by Malleable foundries assure Malleable users of castings that are uniform, part after part, regardless of size or shape. This uniformity, combined with unparalleled physical and mechanical properties, ideally suits Malleable castings for modern America's quality products.

For information or service, call on one of the progressive firms that identify themselves with this symbol—

MEMBER

MALLEABLE

CASTINGS COUNCIL

If you wish, you may inquire direct to the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio, for information.

Better Products at Lower Cost Result From Malleable Uniformity Controls

Uniform quality — whether for five or five million pieces — is essential to maintain product quality and increase manufacturing efficiency. With accelerating frequency, Malleable castings contribute their unique uniformity in critical applications where durable, reliable components are necessary.

Key to Uniformity is Control

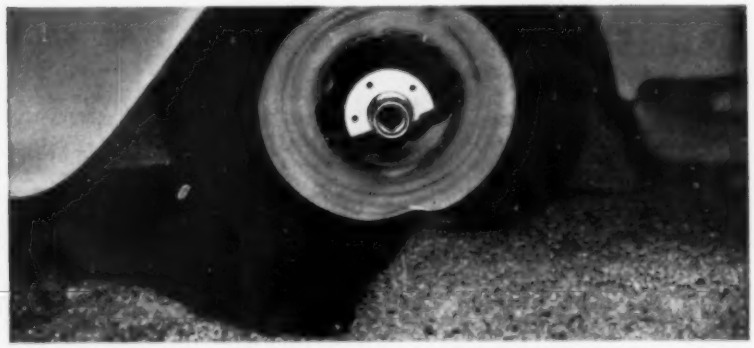
Malleable iron is produced under closely controlled manufacturing techniques. From charge composition and molding sand properties, through final inspection, every critical factor is held constant by using the most modern techniques of metal analysis, process control and inspection.

Internal Uniformity

This versatile engineering material is achieved through converting the base white iron into tough Malleable iron by a controlled heat treating process. Malleable's internal structure exhibits excellent uniformity, an important factor in assuring the dependable performance of intricately designed components.

External Uniformity

Fundamental to the casting process is the ability to produce a given shape, time after time, in either small or large quantities. Metal can be placed exactly where it is needed . . . eliminated where it is not. Good design — achieved through close cooperation between the customer and the foundry — can assure the necessary tolerances and the lowest possible finished part cost. Modern techniques of production and inspection are used to insure top quality, dimensionally accurate castings.



The life of every motorist rides in complete safety on Malleable wheel hubs of unerring uniformity.

Uniformity Proven by Use

The final test of any part is how well it stands up in actual service. Under continuous cyclic and shock loading, the millions of Malleable wheel hubs, which are in service on the front end of every American-made car, have compiled an enviable record of proven uniformity. Another dramatic example of Malleable's uniformity is proved in the old adage "A chain is only as strong as its weakest link." Miles of Malleable chain, carrying tremendous loads year after year without failure, demonstrate the uniformity of every cast link.

New techniques for controlling every element of Malleable production are the result of intensive research done by Malleable foundries in their continuing search for ways to make Malleable even more versatile and indispensable to industry.

More Information Available

Your copy of *Data Unit 103—Uniformity* — is available from any member of the Malleable Castings Council. If you prefer, write direct to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

These companies are members of the

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New Haven Malleable Iron Co., New Haven 4

DELAWARE
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ILLINOIS
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Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
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Westmoreland Mall. Iron Co., Westmoreland

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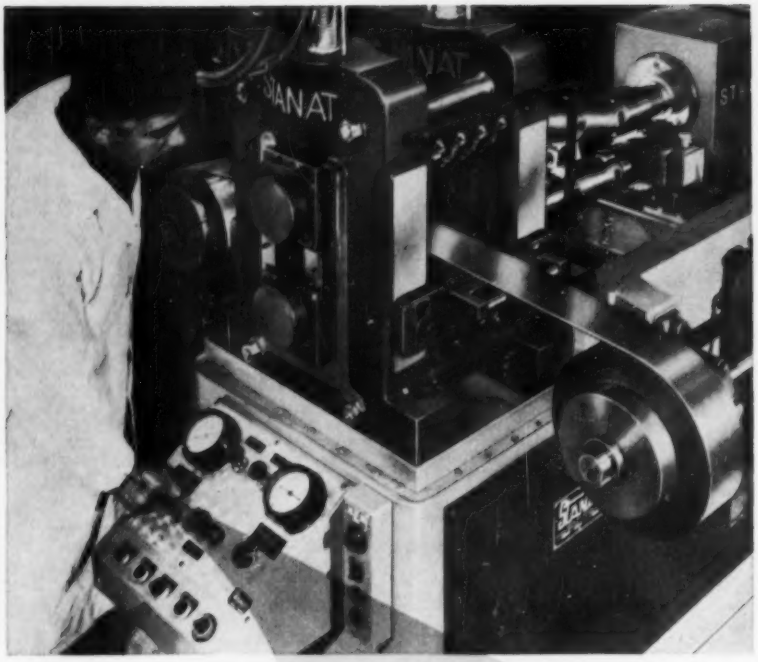
Milwaukee Malleable & Grey Iron Works, Milwaukee 46



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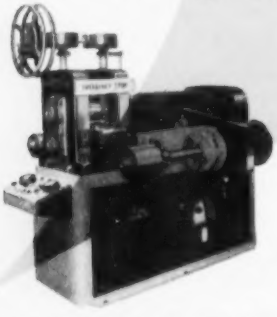

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Developed especially to meet the demand for a low cost, high precision rolling mill for use in laboratories and pilot production plants, these new Stanat mills are available with a complete line of accessories which can be furnished with the mill, or added later. Even the reversing mill feature can be added at a later date.

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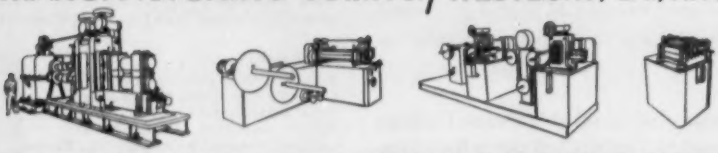

MFR'S OF ROLLING MILLS, GANG SLITTERS, WIRE FLATTENING MILLS, ROLLER LEVELERS AND BULL BLOCKS

Investment Castings . . .

cheaply and larger than by the regular investment process. Ceramic shell molds are light and, for this reason, easier to handle, and require shorter drying and firing times and are easier to knock out. Ceramic shells have not been widely used because the manufacturer awaited a foolproof, simple, reliable process.

General Electric Co. has developed a method called the "Z" process. This process considerably reduces the cost of production. Raw materials are cheaper and cleaning costs lower. Flash dewaxing is the most reliable method for wax removal and firing. Flash dewaxing works because it circumvents thermal expansion of the wax. The wax melts and runs out before the body of wax has had a chance to expand and crack the relatively weak shell. The slip should contain a high concentration of solids to assure minimum cracking. It should also have a high yield and a low viscosity, be tacky toward the grain, and preferably be thixotropic. The slip should have high dried strength. The wax should be a low-expansion type and flow easily during melting. The finished mold with wax in place should be completely dry, strong throughout the firing cycle and resistant to thermal shock. The mold should be strong and have a high finish which is resistant to chemical attack. The maximum casting temperature for the "Z" process should be over 3200° F.

"Ceramic Shell Mold Experiments", by Raymond Rueter, National Aluminate Corp., Chicago – The product is known as Nalcast and can be used with Nalcoag liquid binder to make a variety of thermal shock resistant ceramic shapes, such as ceramic shell molds for investment casting. Nalcast is all one substance, made in four different grindings, two of which are powders, and two stucco grains. Fine detail depends in part on the permeability of the shells.

This has been excellent for clusters that have been poured with a head of molten metal up to 10 in. These shells consist of five coats and were poured in the open without any supports. If the taller heads are desired, then more than five coats must be given or else the shells must

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be given some external support such as loose dry sand. A variety of steels have been poured. Shells are dewaxed by a shock heat treatment between 1000 and 2000° F.

"Alumina Shell Molds for Investment Casting", by F. C. Quigley and B. Bovarnick, Rodman Laboratory, Watertown, Mass. – The material used is alumina (Al_2O_3) in the high-temperature alpha phase. A 16-lb. basic unit contains 187.5 oz. alumina, 57 oz. water, 7.5 oz. ball clay, 1.5 oz. gum arabic and 3.7 oz. hydrochloric acid. All dry ingredients are manually blended with a spatula to disperse the gum arabic in order to prevent its "balling" when water is added. To the water in a 5-qt. porcelain jar mill is added the dry mix. The mill is rolled overnight. The slip is deflocculated and the pH adjusted by the addition of hydrochloric acid, 1 oz. at a time with a 30 min. period between each addition, until the pH is between 3.4 and 4.0.

During the intermediate rolling, air evolves from the slip and builds up to a positive pressure. Each time the jar mill is opened, air is released. Thus the need of a separate de-airing operation is eliminated. In order to ensure proper deflocculation, the final additions of hydrochloric acid should be gradual. The slip is again rolled for several hours, preferably overnight. Opportunity should be given every 30 min. for air to escape until no further evolution of air is observed. The mold is dried for 30 min. at 2200° F.

"Recent Developments in the Glascast Process", by J. D. Pinsula, Corhart Refractories Co., Louisville, Ky. – The material used is 96 or 100% pure silica in the vitreous state. It is therefore not crystalline. The moldmaking technique is similar to those employed in the Monoshell and Nalcast processes. A slightly different powder and wider range of grain sizes may be used in Glascast molds. The new powder is called Glascast No. 58 and is sold in standard particle size of −325 mesh. Glascast 58 has a lower expansion figure, is slightly more refractory permitting higher pouring temperatures, and is less likely to react with a wider variety of metals and alloys, and it costs less than Glascast 56.

Work is being done on the use of small diameter hollow glass tubes for core work. Tubes run from 0.020 to 0.100 in. diameter made of the same high silica glass as that for Glascast. Tubes bent at any angle can be supplied; they withstand the pressure of the hot metal and generally crack under the pressure of the solidifying metal, facilitating removal. The tubes are easily dissolved in molten caustic.

"Special Advantages of the Shell Process", by Ted Operhall, Misco Precision Casting Co., Muskegon, Mich. – The process described is known as Monoshell. The composition of Monoshell is not revealed. An example, similar to the illustration shown on p. 150, shows that a cluster of vanes made conventionally required an investment mold weighing 70 lb., whereas with Monoshell the mold weighed only 18 lb. The preheating cycle was cut from 16 to 18 hr. down to 1½ hr. using Monoshell. Casting techniques are similar to those used in the conventional investment process. Shells are poured under pressure without any backup. An example compares the conventional and Monoshell processes by analyzing the scrap obtained from runs of some 25,000 pieces. Rough X-ray inspection gave 0.02% rejection for Monoshell versus

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In keeping abreast with the development of controlled atmosphere furnaces for carburizing, annealing and brazing, our broad experience has indicated the best high temperature fabrication for each type of service. Our designs are simple and efficient, combining rugged strength with moderate weight.

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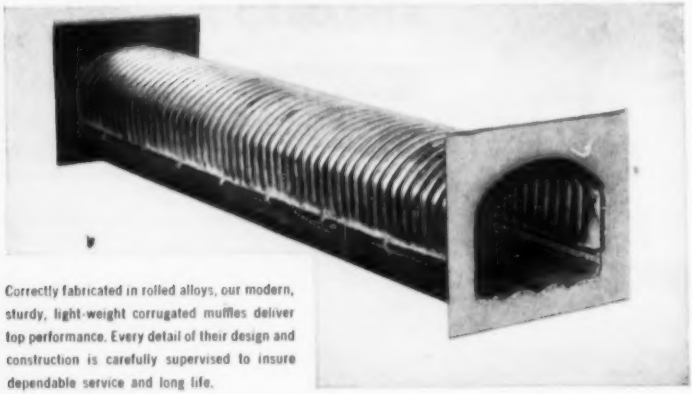

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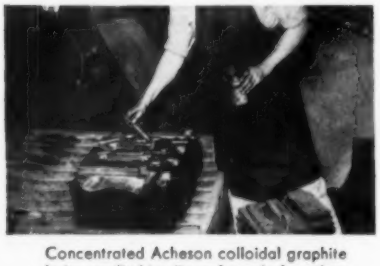
COLLOIDAL DISPERSIONS OF GRAPHITE, MOLYBDENUM DISULFIDE, AND OTHER SOLIDS

COLLOIDAL GRAPHITE PROVES IDEAL AS FORGING LUBRICANT

Lubricants to be suitable for use on forging dies for steel and nonferrous metals must be stable under the high temperatures and pressures involved. Besides providing the most effective lubrication for hot-work dies, 'dag' brand dispersions act as coolants. Total advantages gained by using Acheson colloidal graphite, as described in the following applications are: improved quality of the forging, reduced die wear, lower production costs, and improved working conditions.

'dag' dispersion improves quality, cuts costs for Utica Drop Forge and Tool Division. With a large share of their capacity being devoted to the forging of jet engine blades, Utica finds it must maintain high production, consistently high quality, and a competitive price. Blade-forging dies have a comparatively short life due to rapid wear caused by the thinness of the blades, the high pressures required to form the heat-resistant alloys used, and the closer tolerances required. They have found that *every one* of these requirements can be met by using 'dag' colloidal graphite dispersed in water as their forging lubricant. First, it must withstand temperatures which range from 1950-2200° F. Sprayed on both halves of the die it forms a tightly adhering, smooth, microscopically-thin film that aids metal flow and substantially protects the die itself. In many cases, this has meant fewer finishing operations and therefore higher production, due to the improved quality of the blades. A compressor blade formerly required four blows from upset to finish, with an intermediate heat and tumbling operation. Now, this operation is done in only two blows from original heat. The savings . . . $16,000 a year on this part alone! Add increased life of these precision dies and you can appreciate what a 'dag' colloidal graphite dispersion means to efficient forging. Utica finds water-based dispersions best for press forging, and colloidal graphite in oil the best lubricant for hammers.

Operator spraying colloidal graphite on both top and bottom die halves before forging jet engine blades at Utica Drop Forge and Tool Division, Kelsey-Hayes Company.



Concentrated Acheson colloidal graphite being applied to die surfaces before they are put in service.

Pre-treatment and operational use of 'Aquadag' greatly increases die life. Before putting dies into service, a prominent midwestern manufacturer finds that by preheating them to about 250° F. and brushing on a dispersion of colloidal graphite in water, they have generally *doubled* the working life of their dies. When used as an operational lubricant, die wear on a truck body brace die was proved by actual measurements to be only *one-third* the former rate. And this was with 'Aquadag' diluted 1 to 240 in water! . . . Ample proof of the wide coverage, film toughness, lubricity, and basic economy of a "dag' brand dispersion.

Colloidal graphite is resistant to heat, does not react with the die steel, and the extremely small particle size permits an actual adsorption to the metal surface. A water carrier eliminates the usual smoke and fumes thus affording better working conditions and keeping die temperatures down. After the carrier evaporates, a dry graphite film remains which, besides being an efficient lubricant, protects the die from the accumulation of abrasive dust and scale. Die life is extended from 8 to 14 days and production increased by the reduction in downtime.

Specially compounded, ready-to-use forging lubricants containing 'dag' colloidal graphite are available from industrial lubricant suppliers. If you have a forging lubrication problem, it may pay you to call in your Acheson Service Engineer.

Write for additional information contained in Acheson Bulletin No. 426. Address Dept. MP-59.

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Investment Castings . . .

0.6% for conventional. Superalloys containing titanium and aluminum do not develop surface oxide stringers when Monoshell is used.

"Dipcoats and Investments", by C. R. Whittemore, Deloro Smelting and Refining Co., Ltd., Deloro, Ont. – A detailed description is given of the National Aluminate Corp.'s process for dipcoat. Phosphate bonded investments and zircon air-setting

Pattern Cluster (Top) Was Poured in Conventional Mold Weighing 75 lb. Shell mold (center) is said to weigh only 9 lb. and resulting casting cluster is shown at bottom. (Courtesy of Misco Precision Casting Co.)

LINDBERG FISHER

This nameplate is on all the equipment anyone needs for melting and holding aluminum

Heat and aluminum have been Lindberg's babies for many years. If your product requires the application of heat to aluminum anywhere along the line, we can help you do the job. Lindberg-Fisher furnaces cover every requirement of "heat for aluminum" and embody the latest developments in the field. Many new design and engineering features make Lindberg-Fisher melting and holding furnaces, and accessories, the most modern equipment available to industry.

With Lindberg-Fisher furnaces too, you get the expert technical skills of Lindberg Engineering Company's staff of engineers, metallurgists, technicians, widely experienced in all phases of aluminum melting, casting and treating. Because Lindberg builds all kinds of melting equipment, gas—oil—electric (resistance, 60 cycle induction, arc, or high frequency) . . . we can intelligently and objectively recommend the proper type of furnace to suit your particular conditions and needs.

We can fit the latest melting and holding equipment into your production line efficiently and economically—helping you to manufacture your product to closer specifications, and at a lower cost. Consult your local Lindberg representative. You'll find him listed in the local classified telephone directories in major industrial areas.

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Also factories in: Argentina, Australia, England, France, Germany, Italy, Japan, Scotland, South Africa, Spain and Switzerland.

On the following two pages we've illustrated and described the Lindberg-Fisher equipment that covers all your "heat for aluminum" needs. Will you please turn the page?

LINDBERG heat for industry

FROM THE VERY BEGINNING

Starting with alloyed ingot or molten metal delivery from the reduction cells, aluminum can be processed in a wide selection of furnaces.

In Melting and Holding Furnaces

As shown in the flow diagram molten aluminum is delivered to either large capacity fuel fired reverberatory furnaces, or tilting two chamber induction furnaces for storage at suitable temperature . . . or alloyed ingot is melted and stored in similar furnaces . . . to provide an adequate supply of molten aluminum for the casting station area furnaces.

In Casting Station Furnaces

Molten metal received from the large storage or breakdown furnace described above or from smaller melting furnaces—again either fuel fired or electric, is received at the casting area, maintained at the correct temperature and processed into desired castings. Most of the holding furnaces illustrated can also be used for melting.

Many of the casting station furnaces shown can be equipped with the Lindberg-Fisher Autoladle for automatic ladling or hand ladling.

Hot Metal Delivery

Ingot

Fuel fired reverberatory, melting or holding. Charging well optional.

60 cycle two chamber induction, tilting; melting or holding.

Fuel fired, double reverberatory melting and holding. Especially suitable for alloying. Charging well optional.

60 cycle, two chamber induction, tilting; melting and holding.

60 cycle induction coreless, tilting, especially for melting chips.

Fuel fired, crucible or pot, tilting, melting.

Electric resistance, "radiant muffle," Dry-Hearth, melting and holding, nitrogen atmosphere, especially for insert scrap.

High frequency induction, tilting, melting.

Autoladle for automatic ladling, four standard sizes available, up to 100 lbs.

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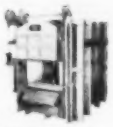
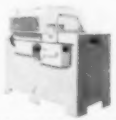
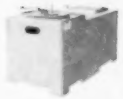


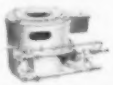
Fuel fired reverberatory, holding or melting.



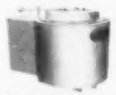
Electric resistance, "radiant dome," reverberatory, holding.



60 cycle, two chamber induction, holding or melting, stationary.



Fuel fired crucible or pot, holding or melting, stationary.



Electric resistance, crucible or pot, holding or melting, stationary.

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Investment Castings . . .

cements are described. Effects of temperature on refractory structure, melting points of synthetic minerals, all are dealt with in detail.

Following this paper, a panel discussed dipcoats and investment defects. C. W. Schwartz, Misco Precision Casting Co., summarized the discussions on excess metal flash on casting, core failure, dipcoat buckles, and metal-mold reaction.

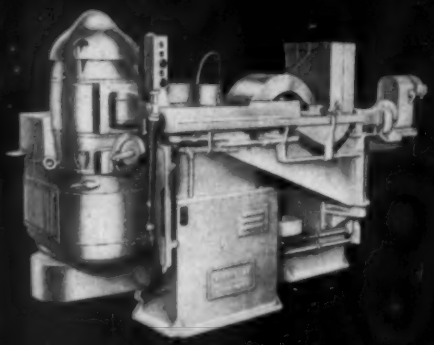
Flash is believed due to "mold crack", caused by wax expansion. Suggested remedies: the use of low thermal expansion wax, greater care in heating the mold, and the use of a staggered pattern. The panel suggested eliminating core failure by making the core opening big enough to permit uniform application of dipcoat and adequate stucco coverage. The core strength can also be improved by increasing the amount of coarse material in slurry.

Dipcoat buckles appear to afflict large flat areas. Remedies suggested are to study the thermal expansion characteristics of dipcoat and investment, and use coarse stucco grain to provide better mechanical lock between investment backup and dipcoat. Several castings showed a slag-pocked surface. The panel believes that this condition is caused by oxidation of the metal as it enters the mold cavity. These oxides react with the silica type refractory in the dipcoat or investment to form small slag pits over the casting surface. Suggested remedies are: provide a reducing atmosphere in the mold cavity by adding trichlorethylene to the hot mold just before pouring, and use more refractory mold materials such as alumina and zircon to reduce the tendency toward metal-mold reaction. H. J. Roast

Ultrasonic Inspection of Aluminum Alloys

Digest of "Ultrasonic Testing of Aluminum Alloys", by William L. Fink, A. S. T. M. Preprint 74, 1957, 6 p.

The Aluminum Co. of America has adopted ultrasonic inspection as a method of testing final products. The Alcoa quantitative standard reference blocks consist of two series,



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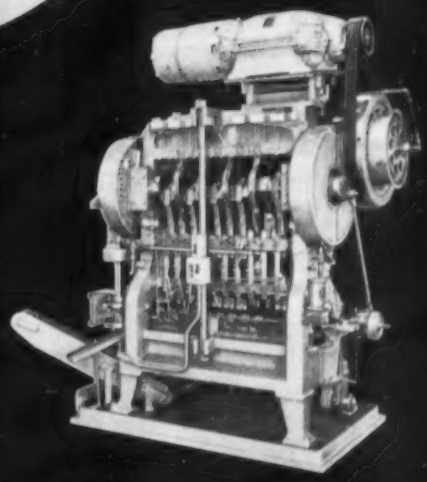

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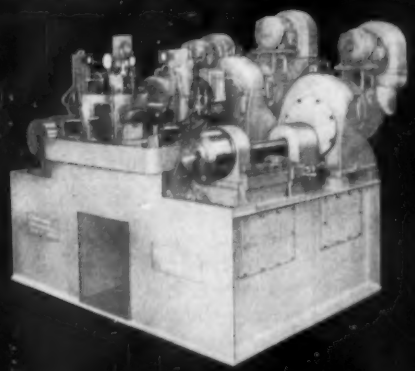

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The series B blocks have only 3/64, 5/64, and 8/64-in. diameter holes, with eleven different metal distances, ¼ to 6 in. for each hole. These are used to check resolving power, penetration, and to correct pip height for metal distance. The curve of pip height versus distance from crystal to discontinuity increases rapidly to a maximum (the "close field"), and then decreases (the "far field"). With higher frequency and large diameter crystals, a large per cent of the material will be inspected in the close field. A curve of pip height versus distance for the maximum permissible discontinuity can be plotted on transparent plastic sheet and attached to the face of an oscilloscope tube. Parts are subject to rejection when any pip goes above the curve. The pips may be observed visually, or electronically monitored to give an audible signal when indications exceed the permissible limits.

A low hash pattern, in sound material, is produced by regions of different grain orientation and solid solutions of different compositions. Larger pips usually indicate discontinuities that arise from porosity or dross inclusions in the original ingot. At times, a small pore in an ingot may be flattened during forging or rolling to give a sizable pip. "Healed" porosity may open up during thermal treatments, so a more critical inspection is obtained when performed after heat treatment.

The pip height is not a quantitative measure of the size of a discontinuity, but reasonable acceptance standards that assure the general quality level of the material can be set up on the basis of corrected pip height.

In order to evaluate the findings of ultrasonic testing, the effect of discontinuities on properties must be known. It was known that, in general, such defects as unhealed porosity and oxide film lower the tensile and fatigue strength only when the applied stress is perpendicular to the plane of the discontinuity. The question then arose concerning the effects of discontinuities and stress-raisers inherent to the design of structural parts.

Lug-type specimens (rectangular, with center-line holes at either end) were machined from a 7075 aluminum alloy forging which had been inspected and found to contain a large number of indications. The coupons were taken from regions showing only hash pattern, and from areas with indications above the hash pattern, in the three principal directions. From the less sound region, the specimens were taken

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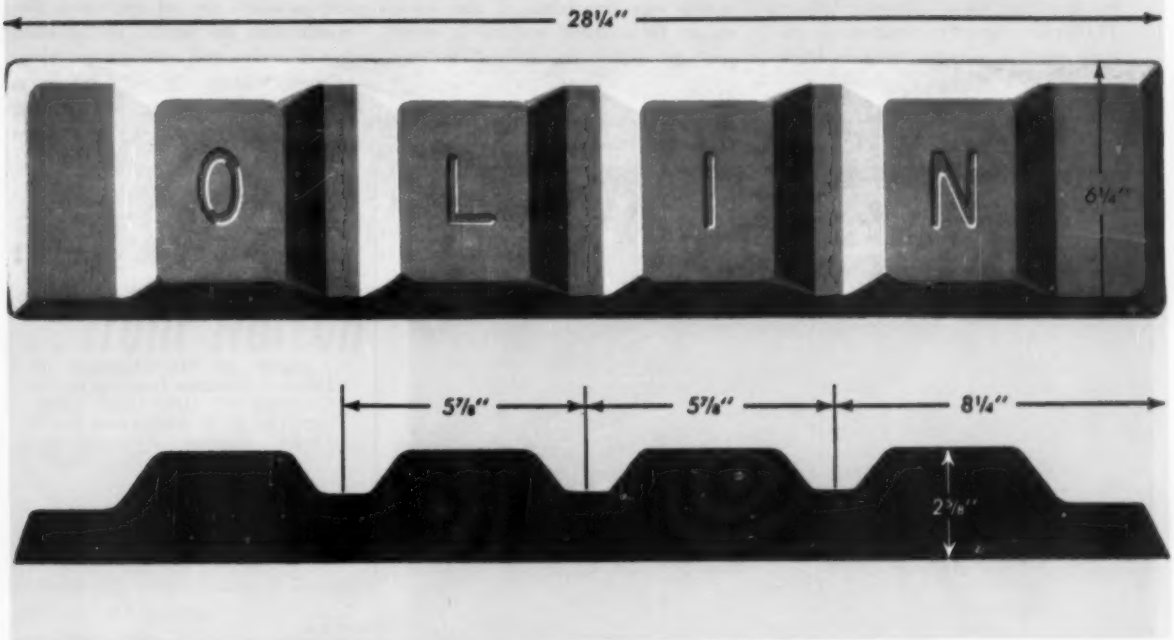

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Ultrasonic Inspection . . .

so that the defects would be in the reduced section, either at the edge of the hole, edge of the specimen, or midway, and others in random positions. Test lugs from the sounder regions could not be cut to place discontinuities in specific locations. Fatigue tests were run on a Krouse 15,000-lb. capacity direct-stress fatigue testing machine, tension loads from zero to maximum, parallel to the long axis.

Discontinuities which lay parallel to the direction of stress had no effect on fatigue life.

For specimens cut so that the plane of the discontinuity lay perpendicular to the stress, discontinuities did not act as point of origin of failure when they were 0.04 in. or more from the edge of the hole; values from these specimens were used to define the normal fatigue strength of the lug-type test piece. Small discontinuities occurring very near the hole initiated fatigue cracks and lowered the fatigue strength, although the loss could not be correlated with defect size.

On the basis of these results, the author suggests that acceptance standards should be set up on a zoning principle in which the most rigid requirements are set up where discontinuities are normal to the loading direction and adjacent to stress-raisers. More liberal standards could be used for defects oriented parallel to the stress and away from critical areas.

W. V. Ward

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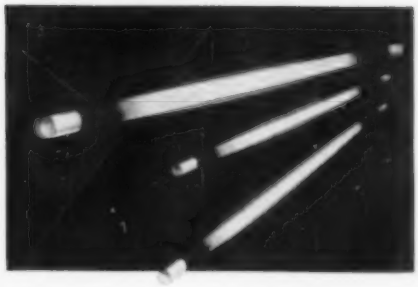
Cracking Due to Stresses in Gray Iron Castings

Digest of "Development of Internal Stresses Leading to the Cracking of Grey Iron Castings", by H. T. Angus and W. G. Tonks, *British Foundryman*, Vol. 50, January 1957, p. 14-22.

Casting stresses left after knocking out are the predominant cause of failure due to cracking, even though the cracks may not develop until further processing has been undertaken, such as machining and heat treatment. The primary cause of this condition is the different cooling rates which exist in a casting.

Stress Development – Above about 750° C. (1380° F.) the capacity of gray iron to withstand stress is so low that deformation, and therefore relief of stress, is easily brought about. Residual stress therefore only begins to develop after the hottest section of the casting has cooled to approximately 700 to 750° C. (1290 to 1380° F.)

In the earlier stages of cooling, the thinner section cools more rapidly than the thicker section. The rate of cooling, however, decreases as the temperature falls and at some point the cooling curves of the two sections cross and the thicker section, by virtue of its higher temperature, cools more rapidly than the thin. At this point, the thicker section may still have a compression stress imposed on it by the thinner section, but as the cooling contraction of the thicker section proceeds, this compressive stress is first of all neutralized and then reversed. Stress will



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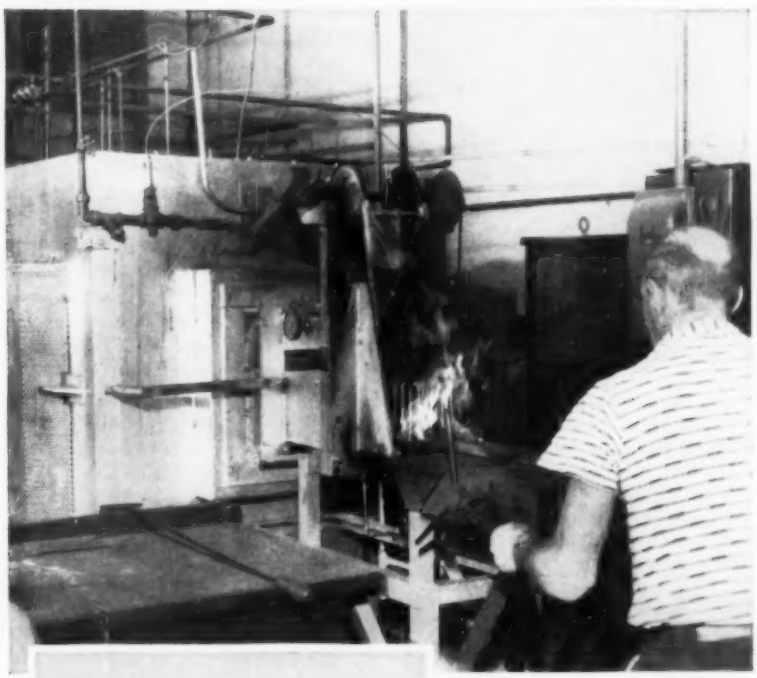

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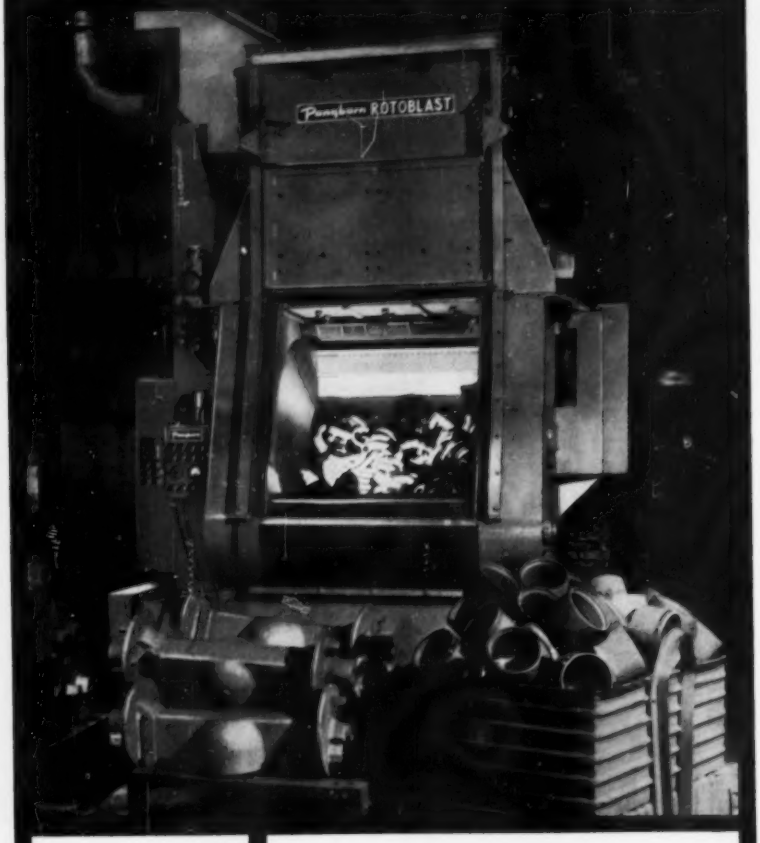

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Stress Cracking . . .

not develop unless there is a substantial temperature gradient in the rigid casting.

Sections of the casting below drawing size due to defective molding or displacement of cores, the presence of notches in a casting, and excessive flash at the mold joint all accentuate cracking.

High clay contents in molding materials substantially reduce the collapsibility of most cores. A core made from clay-free sand and oil or resin-bonded may be harder after baking than a core made from an oil-bonded clay-containing sand, but its effective collapsibility will be considerably greater.

Too low pouring temperatures will give rise to slag and blowhole defects which can act as stress-raisers and initiate cracks.

The use of unsuitable lifting tackle for hot castings, excessive grinding, and redistribution of stresses due to surface conditioning techniques, such as shot-blasting, can all produce cracks in the casting.

Stress Reduction – By running the casting through its thinner section, the sand around this thinner section will be heated preferentially and so retard its cooling at this point.

Choice of knockout conditions is important. Hot knockout is likely to be effective only if carried out while the thicker section is hot enough to permit plastic deformation, that is, above 750° C. (1380° F.), otherwise slow cooling in the mold is preferable. When hot knockout is applied, it is essential to see that the sand is efficiently removed from the required surfaces.

Metal Composition – As a general rule, the following is a useful guide:

1. Gray iron with a low carbon content is more prone to crack than gray iron with a high total carbon content.

2. Gray iron with a high phosphorus content is more prone to crack than gray iron with a low phosphorus content.

3. Gray irons carrying chill are more prone to crack than those free from chill.

The paper then goes on to give practical examples of castings, both large and small, which have cracked due to stress developing mechanisms.

D. R. Baker

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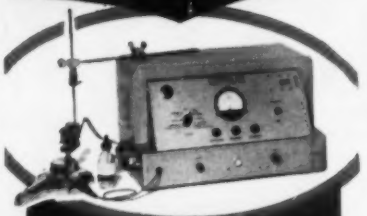

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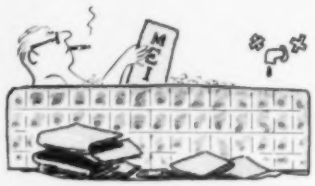

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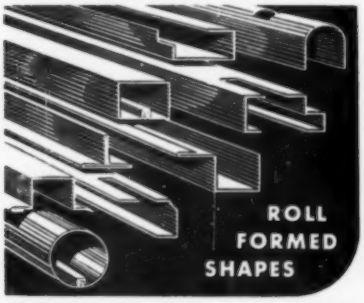

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The ABC of Rust-Lick for Rust Prevention

RUST-LICK, INCORPORATED
735 BOYLSTON STREET
BOSTON 16, MASS.

LIST NO. 105 ON INFO-COUPON PAGE 170

NOW
DU-LITE 3-O
IN USE ON MISSILES

low-temperature black oxide finish for stainless steels

NOW USED IN MISSILE PROGRAM

Du-Lite 3-O is being used on parts for the U. S. Armed Forces and in the Missile program.

Unusually Versatile
Du-Lite 3-O can be used on: Stainless Steels, Cast and Malleable Iron. Nickel Alloys such as: Invars, Monels, Niresist, etc.

Remarkable Low Heat
3-O blackening bath operates at 240°F or less.

No Dimensional Change
Low-temperature 3-O provides maximum activation necessary for coloring stainless steels without surface damage, or dimensional change often caused by other processes which require excessive heat.

Du-Lite
CHEMICAL CORPORATION
1 River Rd., Middletown, Conn.

LIST NO. 103 ON INFO-COUPON PAGE 170

Pickling Tank Test in 3 minutes . . .

WITH FERRO PICKLE PILLS!

Any workman who can tell red from green and count to ten can test the exact strength of pickling solutions . . . *the exact percentage of iron content*, and the solution percentage of sulphuric acid, muriatic acid, alkali etc. in metal cleaning tanks.

Ferro Pickle Pills provide a quick, accurate test to augment periodic titration testing, or as a "test within a test". They can assure full-capacity cleaning with fewer rejects, save money by eliminating premature dumping of tanks. That's why more and more companies are using them. Why don't *you* try them? Write today for literature and prices.

FERRO
FERRO CORPORATION
4133 East 56th Street
Cleveland 5, Ohio

LIST NO. 175 ON INFO-COUPON PAGE 170

STAR STAINLESS SCREW CO.

CORROSION RESISTANT

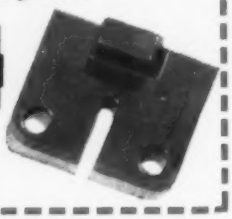
647 Union Blvd., Paterson 2, N. J.
Telephone: CLifford 6-2300
Direct N.Y. 'phone Wisconsin 7-6310
Direct Phila. 'phone WAlnut 5-3660

LIST NO. 99 ON INFO-COUPON PAGE 170

METAL POWDER PARTS / HIGH DENSITY

carburized steel properties in unusual shapes

Supermet specializes in powder metal parts requiring extreme physical properties and/or unusual intricacy. Controlled carburized case plus new approaches to die design bring you steel parts with the economy of powder metallurgy. In electrolytic iron, 7 ranges of properties are available; ask also about stainless steel parts. As an indication of capability, a counter pinion (*) is currently produced with tooth extensions which withstand a 60 lb. load. Previously the part could only be made by machining; now it is fabricated at a 25% saving by the Supermet process. Send your part print today.



GLOBE

SUPERMET DIVISION

GLOBE INDUSTRIES, INC.

1467 Cincinnati St., Dayton 8, Ohio

free technical literature

LIST NO. 174 ON INFO-COUPON PAGE 170

more reproducible results with ultra-pure graphite shapes

for:
METALLURGY
SEMICONDUCTOR PROCESSING
LABORATORY REACTIONS AND ANALYSES

The properties of United's new ultra pure graphites make them exceptional for crucibles, boats, funnels and similar parts. United offers you both stock and custom graphite shapes carefully machined, then purified by the famous "F" Process (developed by United, used by AEC). Your own processes are therefore more reliable, your results more reproducible.

Our R & D and technical service staffs are ready to serve you and can meet your "crash" delivery schedules. Write Dept. F for full details!

UNITED
CARBON PRODUCTS CO.
P.O. BOX 269, BAY CITY, MICHIGAN

LIST NO. 179 ON INFO-COUPON PAGE 170

MULTI MOTION DIES* .... FOR TEST SPECIMENS ...

DL-1001
TENSILE TEST BAR
MPA STANDARD
10-51

- Tensile Bars
- Transverse Bars
- Green Strength
- Bushings
- Slugs
- Stepped Parts

Complete design facilities for dies or subpress units to press unusual shapes in lab presses.

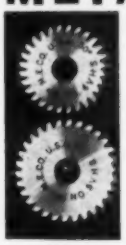
*PATENTS PENDING

HALLER, INCORPORATED

16580 Northville Rd., Northville, Mich.

LIST NO. 149 ON INFO-COUPON PAGE 170

MARTINDALE METAL SAWS



for fast, precision sawing, slotting, mica undercutting

•

HIGH SPEED STEEL OR TUNGSTEN CARBIDE

Milled, hardened and ground by skilled, experienced craftsmen to exacting specifications. Available in ¼" to 4" O.D., complete range of thicknesses and tooth designs, "U" slot or "V" cutters. Get finest saw blade performance—lowest operating cost.

***Send for NEW CATALOG** and prices on these and other maintenance, safety and production products.*

MARTINDALE ELECTRIC CO.
1372 Hird Avenue Cleveland 7, Ohio

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SPECIAL SERVICE ON *HIGH SPEED* STEEL FORGINGS

FAST NATION-WIDE SERVICE ...YOUR STEEL OR OURS

Complete Source For Forged Products Up To 4000#
Rings, discs, spindles, bars or special shapes to your specifications.

28 Years Of Specialized Experience
In production of high speed tool and alloy steel flat die forgings.

Ample Stocks Of Steel Always On Hand

Expert High Speed Steel Blacksmiths

Call or write for free cost quotation on your forging requirements

Smith-Armstrong FORGE, INC.
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A BIG job—for SMALL parts

Every one of these OPC castings represents time and money saved by a manufacturer. You, too, can save time and money by having OPC produce your small parts to the most exacting tolerances, whether you need just a few for experimental purposes or thousands for a production run. Our illustrated brochure shows how and why.

OHIO PRECISION CASTINGS, INC.
Box 55, Sta. A
DAYTON 3, OHIO
Plaster Mold Castings
BRASS • BRONZE • ALUMINUM
BERYLLIUM COPPER

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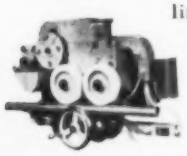
MARKING for any product!

Rubber type, logos and dies . . . imprinting units for rounds or sheets . . . for in-line marking of moving stock.



Steel stamps, dies and machines for marking round, flat or contoured products . . . production marking machines for high-speed automatic lines.

Write for information and literature—indicating product to be marked.

JAS. H. MATTHEWS & CO.
Over 100 Years of Service to Industry
3967 FORBES ST. • PITTSBURGH 13, PA.

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HARDNESS TESTING SHORE SCLEROSCOPE

Pioneer American Standard Since 1907

Available in Model C-2 (illustrated), or Model D dial indicating with equivalent Brinell & Rockwell C Hardness Numbers. May be used freehand or mounted on bench clamp.

OVER 40,000 IN USE

SHORE INSTRUMENT & MFG. CO., INC.
90-35M Van Wyck Exp., Jamaica 35, N.Y.

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Whitelight MAGNESIUM

your comprehensive independent mill source of magnesium alloy . .

ALLOYS
AZ10
AZ31
AZ51
AZ61
AZ81
ZK60
ZK30
M-1
ZK-20
Anodes

RODS ½" dia. to 6½" dia.
BARS, STRIPS .022" min. to 7½" max
SOLID SHAPES .022" min. to 6½" circle
TUBING ¼" O.D. to 6" O.D.
HOLLOW SHAPES ½" to 6½" circle
PLATE & SHEET .092" to 3" thick

WHITELIGHT MAGNESIUM

WHITE METAL ROLLING & STAMPING CORP.
82 Moultrie Street, Brooklyn 22, N.Y.
Factories: Brooklyn, N.Y. • Warsaw, Ind.
Los Angeles Warehouse: 6601 Telegraph Rd.

LIST NO. 213 ON INFO-COUPON PAGE 170

Regulate and control electric ovens and furnaces better, accurately, and efficiently with SORGEL Saturable Reactors

Any amount of A.C. power from 1 Kva to 3000 Kva, single phase or 3-phase, at any voltage, can be controlled, regulated, and varied in stepless increments, with SORGEL Saturable Reactors.

The control can be a small manually operated hand wheel that can be placed in any desired location, or it can be automatically controlled, regulated and varied by a thermostat or any other instrument or device.

SORGEL reactors are designed to meet your exact requirements. Let us know what your problems and requirements are, and we will submit our recommendations with complete information.

Write for Bulletin 658.

Saturable Reactor with tap changing transformer

•

Also a complete line of dry-type transformers.

All standard and intermediate ratings, ¼ Kva to 10,000 Kva, 120 to 15,000 volts.

•

Sales Engineers in principal cities

Consult the classified section of your telephone directory, under the heading "Transformers," or communicate with our factory.

Sorgel Electric Company
834 W. National Ave., Milwaukee 4, Wis.
Over 40 years of electrical manufacturing development

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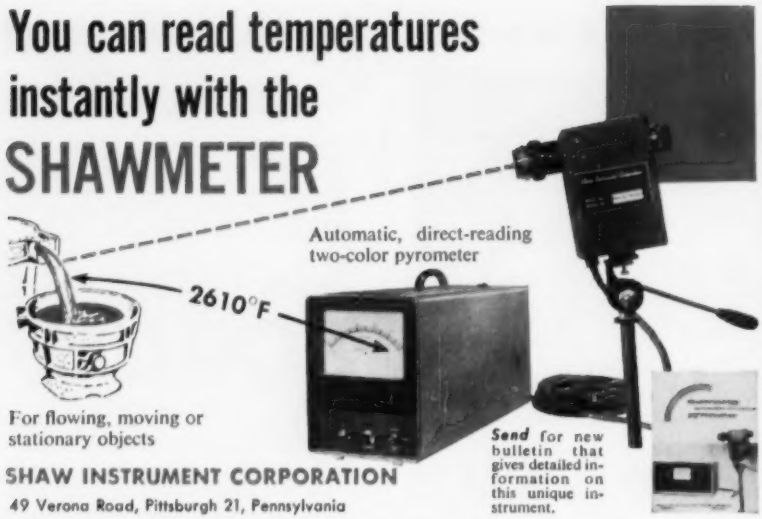
You can read temperatures instantly with the SHAWMETER



For flowing, moving or stationary objects

SHAW INSTRUMENT CORPORATION

49 Verona Road, Pittsburgh 21, Pennsylvania

Send for new bulletin that gives detailed information on this unique instrument.

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TENSILKUT

Tensile and fatigue test specimens can be accurately machined from foil metals as light as .0005" or heavy .500" plate in less than two minutes. Machined edges are completely free of cold working and the specimen configurations are duplicated within ± .0005".

TensilkuT machines a wide range of metals including steel, aluminium, stainless steel, copper, titanium, uranium, lead, the super alloys and all plastic materials.

Tensilkut table and floor models are available with motors from ⅛ to 2½ HP. Write for our latest brochure.

Trade Mark Registered U.S. Patent Office Patents Pending United States & Canada.

SIEBURG INDUSTRIES

INCORPORATED

Danbury Industrial Park • Danbury, Conn.

LIST NO. 131 ON INFO-COUPON PAGE 170

THE NEW

DERMITRON

NON-DESTRUCTIVE COATING THICKNESS TESTER

FAST... ACCURATE NON-DESTRUCTIVE DIRECT-READING

- Instantly measures the thickness of metallic and non-metallic coatings and films
- Based on eddy-current principles
- Enables measurements on small or otherwise inaccessible areas

This portable instrument for both laboratory and production use, gives fast, accurate and direct readings of virtually any coating on any base, including:

- Metal coatings (such as plating) on metal base (magnetic and non-magnetic)
- Non-metallic coatings (such as paint, anodizing, hard-coat, ceramic) on metal base
- Metal films (such as vacuum metalizing) on non-metallic base (plastics, ceramics)

Write for latest bulletins and questionnaire to help solve your thickness testing problems

UNIT PROCESS ASSEMBLIES, INC. UPA

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ULTRASONIC

INSPECTION SERVICE

A COMPLETE SERVICE PROVIDING DAY TO DAY ULTRASONIC TESTING FOR THE DETECTION OF FLAWS IN MATERIALS.

FIELD TESTING SERVICE

LABORATORY TESTING SERVICE

CONDUCTED BY SPERRY ENGINEERS LOCATED THROUGHOUT THE COUNTRY.

Descriptive literature available.

Sperry

Sperry Products, Inc.

DANBURY, CONNECTICUT

LIST NO. 206 ON INFO-COUPON PAGE 170

Leitz MINILOAD TESTER

FOR VICKERS AND KNOOP HARDNESS

STANDARD HARDNESS TESTERS for ROCKWELL and BRINELL TESTS also available.

Request Catalog 72-1

OPTO-METRIC TOOLS, INC.

137 MP VARICK STREET, NEW YORK 13,

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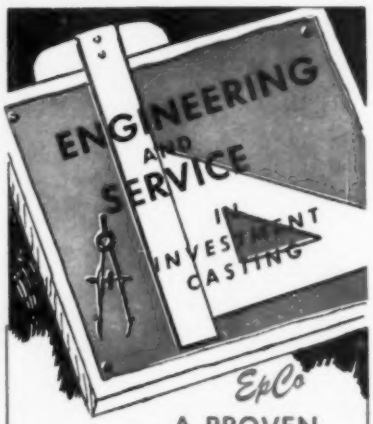


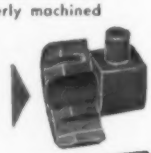
EpCo

A PROVEN DEPENDABLE SOURCE

FOR BETTER GRADE INVESTMENT CASTINGS IN FERROUS AND NON-FERROUS METALS

INVAR CASTING Special Feature — Nickel content held to 35% minimum — 36% maximum

STAINLESS STEEL PART for milk bottling unit formerly machined from solid stock. Only finish operations required are reaming small dia. of counterbored hole and drilling and tapping for set screw.



ENGINEERED PRECISION CASTING CO.

MORGANVILLE, N. J.

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GET A BID FROM

HOOVER

SPECIALISTS IN THE FIELD OF

Die Castings

SINCE 1922

Aluminum and Zinc

THE HOOVER COMPANY
Die Castings Division
North Canton, Ohio
In Canada—Hamilton, Ontario

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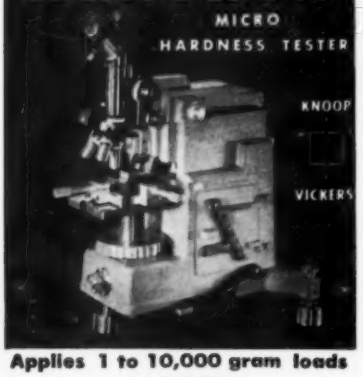
KENTRON

MICRO HARDNESS TESTER



Applies 1 to 10,000 gram loads

Write for Bulletin

Kent Cliff Laboratories Div.
The Torsion Balance Company
CLIFTON NEW JERSEY

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SUB-ZERO

low temperature equipment

for

- shrink fits
- seasoning gauges
- precision tools
- laboratory testing

1.5 and 6.5 cu. ft. capacities. Sturdy, all-steel cabinet construction. Sublids for constant inside temperature. Adjustable temperature controls. Special accessories available.

For more information—Write to: **Revco INC.**
Deerfield, Michigan
Specialists in Trend-Setting Refrigeration

LIST NO. 200 ON INFO-COUPON PAGE 170

Solve
Inspection
Sorting
Demagnetizing
Problems

with
MAGNETIC ANALYSIS...

MULTI-METHOD EQUIPMENT

Electronic equipment for non-destructive production inspection of steel bars, wire rod, and tubing. Detects mechanical faults and variations in composition and physical properties. Average inspection speed — 120 ft. per minute.

MULTI-FREQUENCY EQUIPMENT

An eddy current tester with six inspection methods operating simultaneously — for high-speed, non-destructive testing of non-ferrous and non-magnetic tubing, bars and wire from ⅛" to 3" diameter. Detects both surface and sub-surface flaws, and variations in chemical, physical and metallurgical properties at speeds of 200 to 600 ft./min.

WIRE ROPE EQUIPMENT

Electronic equipment for inspecting ferro-magnetic wire ropes from 1/32" to 3" diameter. Detects broken, cross-over or missing wires, plus defective welds and deformations at production speeds up to several hundred feet per minute.

COMPARATORS AND METAL TESTERS

Electronic instruments for production sorting of both ferrous and non-ferrous materials and parts for variation in composition, structure and thickness of sheet and plating.

DEMAGNETIZERS

Electrical equipment for rapid and efficient demagnetizing of steel bars and tubing. When used with Magnetic Analysis Multi-Method Equipment, inspection and demagnetizing can be done in a single operation.

MAGNETISM DETECTORS

Inexpensive pocket meters for indicating residual magnetism in ferrous materials and parts.

"THE TEST TELLS"

For Details Write:

MAGNETIC ANALYSIS CORP.
42-44 Twelfth St., Long Island City 1, N. Y.

LIST NO. 51 ON INFO-COUPON PAGE 170

revolutionary • low cost
Newage
MICROHARDNESS TESTER

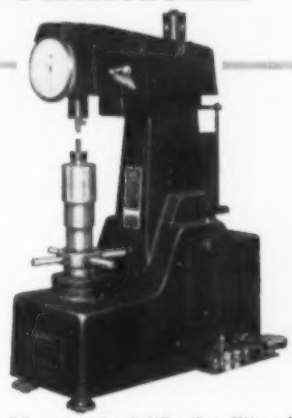
- permits direct, accurate readings corresponding to Vickers within a few seconds
- ideally suited for on-the-job production work
- eliminates a microscope, conversion charts, complicated tables
- for rapid and accurate checking of surface layers, thin sheets, flat springs, instrument parts, wire, punches, etc.
- can be obtained in 1 kg or 2 kg loads penetrating as little as .0007" or .0016" respectively

NEWAGE INDUSTRIES, INC.
222 YORK ROAD
JENKINTOWN, PA.
TUrner 4-8494

Write, wire or call for full details

LIST NO. 207 ON INFO-COUPON PAGE 170

Wilson "Rockwell" TWINTESTER



- Measures both "Rockwell" and "Rockwell" Superficial hardness on B, C, N, T and other scales
- Easy to operate—change from "Rockwell" to "Rockwell" superficial testing in seconds
- Large direct-reading dial with one zero set position for all scales
- Complete equipment includes cowl, ball penetrator for B and T scale, "Rockwell" test blocks, anvils, dust cover, and protective sleeve set
- Complete line of accessories available

Write to Dept. DU. Ask for Bulletin TT-59

WILSON "ROCKWELL" HARDNESS TESTERS

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
230-FB Park Avenue, New York 17, N.Y.

ACCO

LIST NO. 209 ON INFO-COUPON PAGE 170

IMPACT BRINELL
HARDNESS TESTER

New

- RELIABLE
- RUGGED
- NO ADJUSTMENTS
- REALLY PORTABLE
- PRICED RIGHT

$79.00

Complete with
Magnifying Glass
Test Blocks
Carrying Case

NEWAGE INDUSTRIES INC.
222 York Road Jenkintown, Penna.

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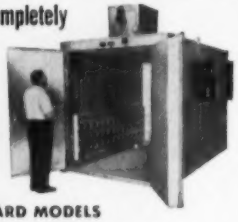
GRIEVE-HENDRY
WALK-IN OVENS

Shipped Completely "Set - Up"

Previously Tested and ready to operate.



6 STANDARD MODELS

No engineering charges

Latest convenience features and safety devices included. Design changes to suit requirements. Electric, gas or oil heated. Write for bulletin.

87 Standard Bench and Cabinet Models $110.50 and up

GRIEVE-HENDRY CO., INC.
1389 W. Carroll Ave.,
CHICAGO 7, ILL.

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LUCIFER FORCED AIR FURNACE

The Lucifer Furnaces, Inc., Series 4055 furnaces are manufactured in ten standard models with 800° F. or 1250° F. maximum operating temperatures. These furnaces are designed for tempering, drawing, heat treating aluminum, and glass annealing. Each furnace is a complete unit . . . controls included. They are equipped with a large fan and motor to force circulation of air in the working chamber to insure maximum uniformity of temperature.

All electric heat treating furnaces by Lucifer feature • low initial cost • low upkeep • top production performance • minimum replacement downtime. For free engineering advice, parts, or product information . . . write, wire or call . . .

LUCIFER FURNACES, INC.
Neshaminy 7, Penna.
Diamond 3-0411

LIST NO. 122 ON INFO-COUPON PAGE 170

How to Cut Pot Costs:

Buy low-cost Eclipse pressed (not welded) steel pots . . . and replace them on a regular schedule.

1 Lower initial cost
2 Elimination of failures
3 Faster, more even heating
4 Quantity discounts earned on your total purchases in any 12 month period.

Guaranteed free from defects. Write:
Eclipse Fuel Engineering Company
Industrial Combustion Division
1127 Buchanan St., Rockford, Ill.

Eclipse PRESSED STEEL POTS

LIST NO. 176 ON INFO-COUPON PAGE 170

READY TO GO!

A Complete Line of HIGH TEMPERATURE, HIGH VACUUM Retort Furnaces

HORIZONTAL BELL and PIT Types

Ready to Install and Operate

TYPE 101. 6" Dia. x 12" Long Uniform Hot Zone. Larger Sizes on Request

- Vacuums to 10^{-6} m. m. • Temperatures to 2200°F
- With or without isolated cooling systems
- Semi-Continuous Features
- Single or Double-Pumped

Whatever Your High Vacuum Problem Write Us Immediately

GENERAL VACUUM CORPORATION
400 BORDER ST., EAST BOSTON 28, MASS.

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WELDING STAINLESS?

Contact "Whitey" (Mr. Electrode)

Whitey knows the ropes when it comes to welding stainless . . . and he's happy to help with your welding operations. His years of experience, plus the trusted welding materials of Maurath, add up to a guarantee of quality welding. Call Maurath for stainless and heat resistant arc welding electrodes of all analyses . . . coated, straightened . . . cut . . . coiled and spooled.

Quality Is Remembered Long After Price Is Forgotten

MAURATH Incorporated
21830 Miles Avenue
North Randall 22, Ohio
Phone: MOntrose 2-6100

LIST NO. 72 ON INFO-COUPON PAGE 170

FREE

the QUENZINE STORY

Low priced, more readily available carbon steels can often replace alloy steels when quenched in Beacon Quenching Oils with QUENZINE added. For information on this new additive and other Beacon Brand Heat Treating Compounds write to . . .

KELCO

ALDRIDGE INDUSTRIAL OILS, Inc.

3401 W. 140th St., Cleveland 11, Ohio

LIST NO. 29 ON INFO-COUPON PAGE 170

other extruders said it couldn't be done . . .

GENERAL DID IT!

The manufacturer of heaters wanted a hearth bottom — a fluted, gold-anodized aluminum extrusion. Specifications called for a 7" x .050" shape. Extruders with presses that take 8" diameter billets said it couldn't be done because of the thinness, too great a reduction ratio.

G.E.I. engineers came up with the extrusion, on a 5" press! The shape is extruded half round, then straightened, notched and bent, holes punched, and finally gold-anodized.

If you have a problem involving aluminum fabrication, finishing or extrusion, why not take it to General, pioneers in developing new uses for extruded aluminum.

GENERAL EXTRUSIONS, INC.

4040 Lake Park Rd., Youngstown, Ohio

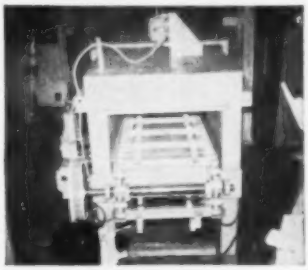
Mill Representatives at St. Louis, Detroit, Pittsburgh, Cincinnati, and Chattanooga

Consult your classified phone book under Aluminum Products

LIST NO. 141 ON INFO-COUPON PAGE 170

GOOD USED EQUIPMENT AT REAL SAVINGS TO YOU!

LIKE-NEW MORRISON CONTINUOUS CHAIN BELT TEMPERING AND STRESS RELIEVING OVEN



Working Dimensions: 30" w x 160" l x 13" h Calrod heated for 850° F, 440 volts, 60 kw. Circulating Fan in Roof, Complete.

Also:

Recirculating Gas-fired tempering Furnace IWD: 28" w x 55" l x 45" h. 3 Shelves.

Brand New Ajax Submerged Electrode Salt Pot, Original Crates, 12" w x 42" l x 24" d. Type HCS, 1850° F, 90 kw., 440 volts, Complete.

Brazing Roller Hearth, 24" w x 20' l x 11" h, 2050° F, 70' cooling section, Complete.

Recirculating continuous mesh belt tempering oven, 28" w x 14" h x 42' l, 800° F, 440 volts, 65 kw.

Roller Hearth Recirculating Tempering Furnaces, 48" w x 26" h x 45' l and 17½' l, Gas fired, 1250° F. Complete and like new.

Wire or call for our complete list of used heat treating and plating equipment.

METAL TREATING EQUIPMENT EXCHANGE, INC.
9825 GREELEY ROAD
DETROIT 11, MICHIGAN

LIST NO. 142 ON INFO-COUPON PAGE 170

make hardness tests ANYWHERE WITH THE **NEWAGE TESTER**

- CLAMPS, JAWS & BASE PLATE ARE ELIMINATED
- NO CONVERSIONS OR CALCULATIONS
- TEST ANY SIZE, SHAPE OR TYPE METAL
- NO SKILL REQUIRED
- SCALE READINGS IN ROCKWELL & BRINELL
- ACCURACY GUARANTEED

Many thousands used by industry and government. Write, wire or call for additional details and prices.

NEWAGE INDUSTRIES, INC.
222 York Road, Jenkintown, Pennsylvania
TUrner 4-8496 Dept. MP

LIST NO. 163 ON INFO-COUPON PAGE 170

FAST • ACCURATE

Low Cost Analysis HIGH TEMPERATURE ALLOYS

Crobaugh Laboratories uses new X-Ray Spectrometer and conventional methods to get accuracy from 1 p.p.m. range to 100%.

COMPLETE METALLURGICAL TESTING SERVICE FOR

- Hydrogen, Oxygen, Nitrogen Analysis
- Elevated Temperature Tensile and Stress Rupture
- Low and High Temperature Impact
- X-Ray, Gamma-Ray Radiography

Write for Complete Facilities Brochure

THE FRANK L. CROBAUGH CO.
Member • American Council of Independent Laboratories
3800 Perkins Ave. • Cleveland 14, O. • UT 1-7320

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STANWOOD HEAT TREATING EQUIPMENT RETORTS and STACKING BASKETS

• REPRESENTATIVES IN PRINCIPAL CITIES

of new
Cor-Wal construction
give you:
• Lighter weight—yet stronger
• Longer service life
• Sides are heat resistant corrugated rolled metal
• Basket grid, grid supporting ring and top ring are of high temperature cast alloy
• Proved in exhaustive tests on the job
WRITE FOR DETAILS
STANWOOD CORPORATION

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Portable and Precise
HARDNESS TESTER

Model ST-5

- **Weight: 7 oz.**
- **Length: 6¾ in.**

Direct scale readings in Rockwell and Brinell. Make hardness tests anywhere in seconds. Ideal for testing specimens too large for standard testing equipment. Saves time and labor moving heavy pieces to a bench-tester. Quickly calibrated. Easy to read. Used by many large industries. Accessory equipment includes test stand and carrying case.

Write for full information.

MECHANICAL DEVICES, Inc.
10640 Harper Ave., Detroit 13, Mich.

LIST NO. 167 ON INFO-COUPON BELOW

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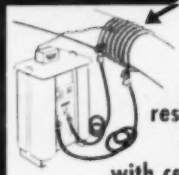

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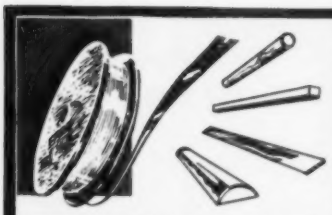

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Effect of Surface Finish on Fatigue

Digest of "The Effect of Surface Finish on Fatigue", by B. Cina, *Metallurgia*, Vol. 55, January 1957, p. 11-19.

FATIGUE TESTING is normally carried out on specimens which have been mechanically polished. However careful the operator may be, there is always the possibility of the results being influenced by an unknown amount of cold work or by hidden scratches. To investigate this effect of surface finish, the author has made fatigue tests on mechanically polished and electrolytically polished specimens of stable and unstable austenitic, fully ferritic and martensitic stainless steels, and a low-alloy steel. The steels were tested in the heat treated condition, the tensile strengths ranging from about 64,000 to 255,000 psi.

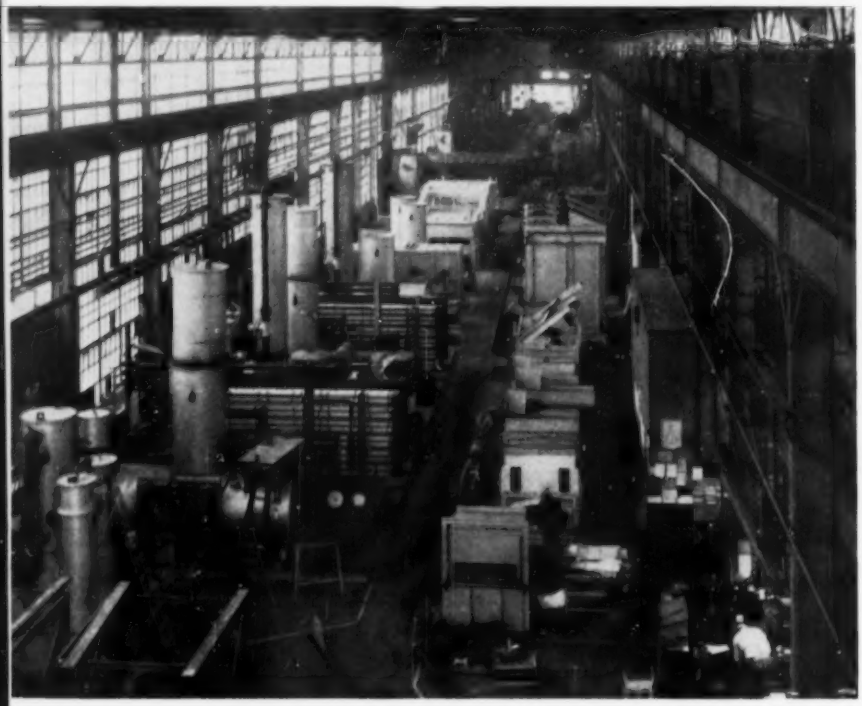
The tests were made under both axial loading and rotating cantilever, single-point loading conditions. Mechanically polished specimens were finished with 000 emery paper, after polishing with successively finer grades, all in a circumferential direction. Electropolished specimens were emery polished to 1M paper, and then treated in a glacial acetic acid-perchloric acid (20:1) bath with a stainless steel sheet as cathode. The polishing time was adjusted to insure the removal of 0.001 to 0.0015 in. of the material, which preliminary experiments had indicated was necessary to get rid of hidden scratches. It was confirmed, furthermore, by X-ray diffraction examination, that this treatment was sufficient to remove the cold work effects of the prior mechanical polishing.

In general, the S-N curves were based on the results of eight to ten tests, of which two were run-outs (25×10^6 cycles), although in certain cases fewer specimens were used. Rotating cantilever tests on six steels showed a reduction in fatigue limit after electropolishing from 4000 to 13,000 psi., depending upon the alloy. A small number of axial loading tests on two other alloys, however, showed very little effect due to electropolishing.

The effect of a vacuum stress-relief treatment was to reduce the rotating-bending fatigue limit of mechanically polished specimens of one alloy to about the same extent as electropolishing. In a further series of similar tests on the effect of cold working, the fatigue limit of electropolished specimens was increased about 18,000 to 20,000 psi. by cold drawing or cold stretching 20%; mechanical polishing gave a 13,000 psi. increase.

Examination of the fractures showed that in electropolished specimens more cracks contributed to the failure than in mechanically polished specimens; this difference was less significant near the fatigue limit, as might be expected. The only exception was an as-hardened 13% chromium steel.

Finally, a comparison was made between mechanically polished and electropolished specimens of two steels under axial and rotating-bending loading. The fatigue limits for the electropolished specimens were



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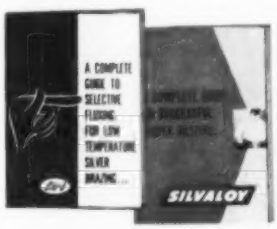

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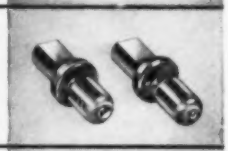

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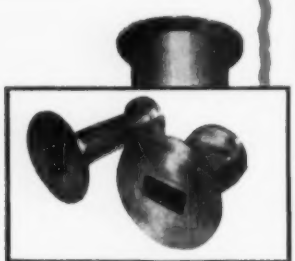

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Fatigue . . .

within about 4000 psi. for the two loading conditions, whereas the mechanically polished specimens gave results some 10,000 psi. higher in rotating-bending. No specimens of the latter type were tested under axial loading, but it is presumed that they would be comparable with electropolished specimens.

The author concludes that mechanical polishing results in an artificially higher fatigue strength due to the cold working of the surface layers and the residual stresses introduced, whereas electropolishing gives a truer value, since it reveals the virgin surface of the material. Furthermore, the discrepancy between rotating-bending and axial loading test results is considerably reduced by electropolishing.

R. C. A. THURSTON

Acid Resisting Property of Steels

Digest of "A Potentiostat Technique for Studying the Acid Resistance of Alloy Steels", by C. Edeleanu, *Journal*, Iron and Steel Institute. Vol. 188, February 1958, p. 122-132.

RESISTANCE to acid solutions is a complex property which cannot be measured on any absolute scale, and with conventional methods it is sometimes difficult to follow with any degree of certainty the effects of a change in composition or heat treatment. A change in composition may greatly improve resistance to one particular concentration of a given acid, but at the same time also lead to a decrease in resistance to a different concentration of that acid or to other acids.

The author divides the acid resisting property of steels into the following headings:

Resistance of metal to highly oxidizing conditions.

Range of passivity.

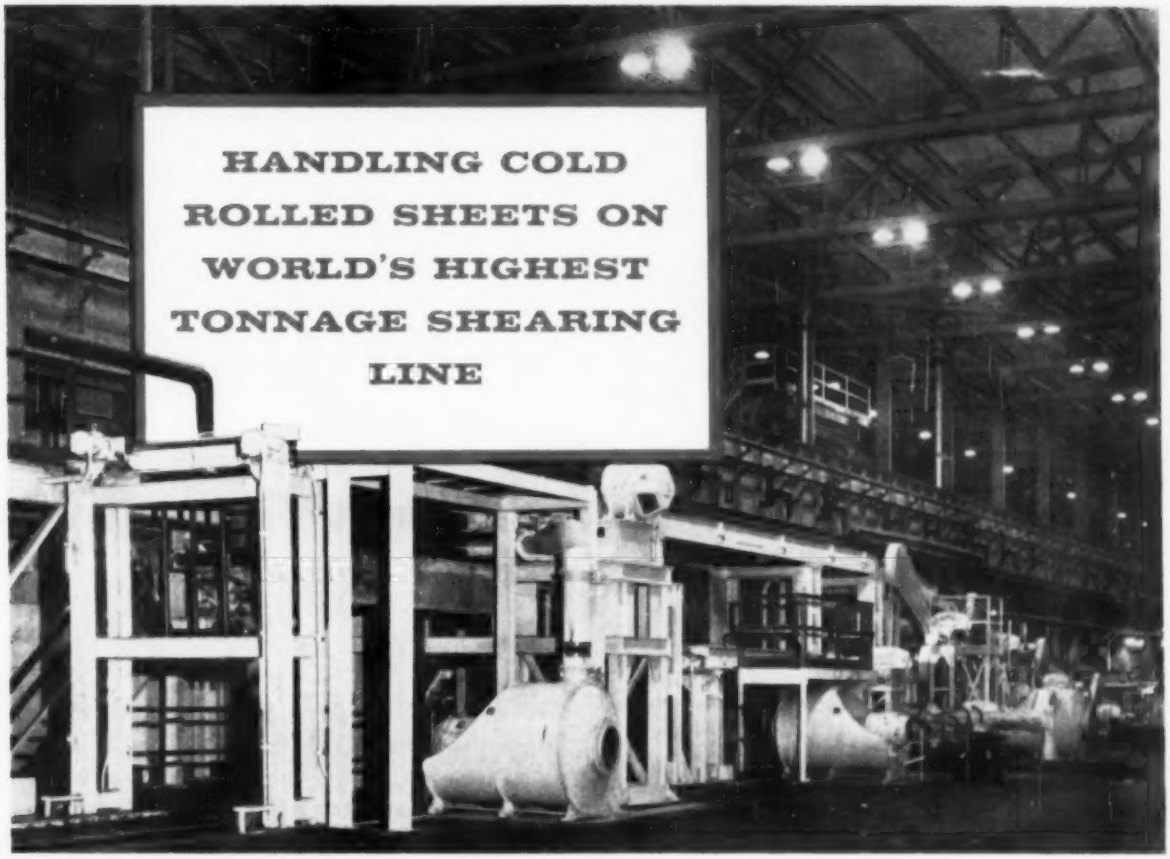
Rate of corrosion of the passive metal.

Stability of passivity.

Maximum rate of corrosion.

Relative nobility.

By using a potentiostat technique, these are measured and compared to give a great deal of



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With a quickening pace, Stokes vacuum metallurgical equipment is helping industry find new paths to profit through a combination of intensified research and practical production techniques.

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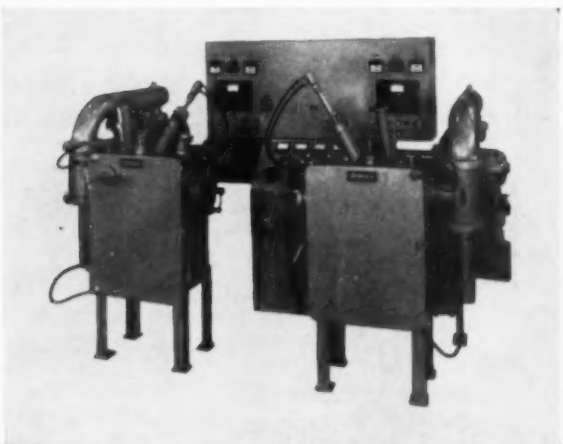
New applications for metallizing are developing at a rapid pace. Vacuum coating with corrosion resistant cadmium and aluminum is playing an increasingly greater role in production of critical, high tensile strength aircraft parts. Lustrous layers of aluminum, vacuum applied on inexpensive metals, can produce quality outdoor lighting reflectors at lower costs. Electronic components, such as resistors, utilize vacuum deposited metallic coatings to achieve weight and space savings with improved reliability, stability and uniformity of temperature coefficient.



High order investigations in vacuum melting are made possible with this Stokes 50-lb. vacuum furnace. A production unit as well, it is available in single or dual chambers plus a variety of automatic types. The unit is shipped as a completely assembled, ready-to-operate system to save customers time and money.

Technological Breakthroughs

Vacuum Metallurgical Equipment

system . . . Stokes becomes a single source of responsibility for performance and reliability. The same unique design and fabrication ability is easily and economically applied to many types of special metallurgical equipment to meet specific customer requirements.

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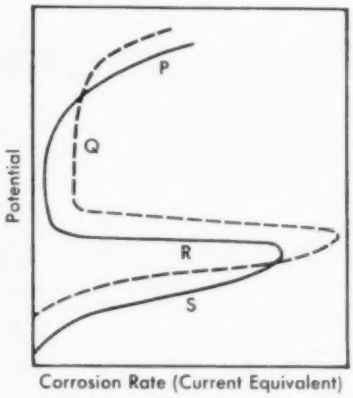
STOKES

Acid Resistance . . .

information about the corrosion characteristics of alloys and the understanding of some of the apparent discrepancies found in alloy acid resistances.

The rate of corrosion in a simple case is dependent on potential in the manner shown in the figure, which gives diagrammatically the curves for two different steels. This curve, a potential/corrosion-rate curve, is obtained by carrying out loss of weight measurements at constant potential using a potentiostat. A similar but slightly distorted curve is obtained from current versus potential measurement. The curve can be regarded as an anodic polarization curve by substituting the equivalent current for the corrosion rate, and from it, it is possible to determine the rate at which the anodic, electron-producing reaction occurs at any given potential.

If a highly oxidizing solution is considered, the cathodic polarization curve occurs at a high potential and the resistance to highly oxidizing conditions is controlled by the position of portion P of the P/C (potential/current) curve. The range of passivity is given by the length of portion Q and represents the range of potential over which the steel has a very low rate of corrosion, and its magnitude is determined by the lateral position of portion Q. The stability of passivity is a measure of the probability of the potentials on Q, for a given environment, remaining constant and not shifting to the region R. The maximum rate of corrosion is the maximum of the loop formed by portions R and S; it is the highest rate of corrosion of the steel and the rate at which it corrodes just before anodic passivity establishes itself. The relative nobility of the metal depends on the position of portion S and it controls the rate of corrosion of the nonpassive metals. The more noble a metal is, the less rapidly it will corrode in solutions in which passivity is impossible.



Potential/Corrosion-Rate Curves for Two Hypothetical Steels

P/C curves for a number of systematic alloys have been determined with the potential both rising and falling. Relative to highly oxidizing conditions, P/C curves on low-chromium steels with 18% nickel show that appropriate changes in portions P and Q for the various alloys can explain the apparent inconsistency that a high chromium

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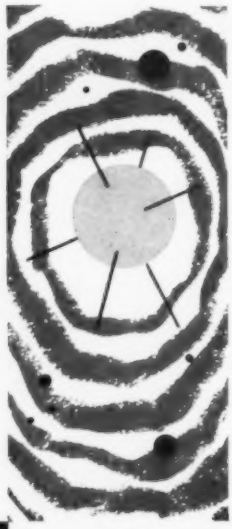

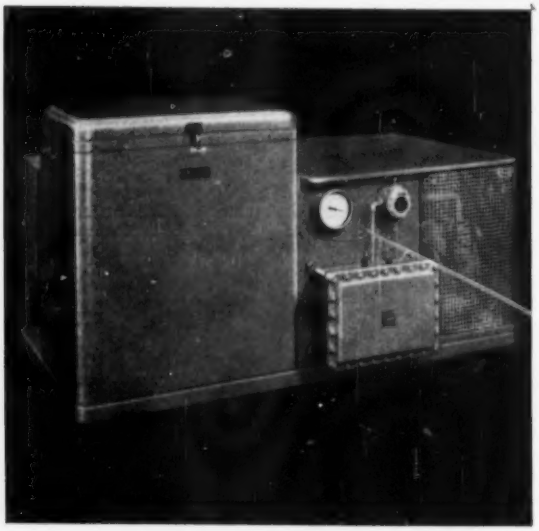

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STRAITS TIN REPORT

News of developments in the production and uses of tin

MALAYAN TIN BUREAU

Tinned sheet steel, available up to 22 gage, has the strength of steel, and good formability in addition. The coating also serves as an excellent paint base and doesn't require a primer coat. For these reasons it is widely used in the automotive industry for air cleaners, oil filters, covers, vents and hot-air ducts.

Modern pewter is nontarnishing and nontoxic, contains no lead, and does not darken or lose its surface finish. It contains 93% tin, 6% antimony, and 1% copper. Surface finish ranges from a bright, high polish to a subdued satin texture. It can be cleaned with soap and water. Frequent polishing is not necessary.

De-icing problem? Perhaps this is the answer. Years ago a transparent electroconductive coating, containing tin, was developed for aircraft. The thin tin-oxide film is applied to glass. A low current passing through the coating generates sufficient heat to de-ice the glass, now standard equipment on most commercial and military planes.

Phosphor bronze, a tin-copper alloy containing up to 10% tin is used in over 30 different aircraft applications. Typical uses are for bushings, bearings, springs, valves, contacts, thermostats and switches.

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The Malayan Tin Bureau
Dept. 25E, 1028 Connecticut Ave., Washington 6, D.C.

Acid Resistance . . .

content is an advantage in, say, 65% HNO_3 but not in the more strongly oxidizing solutions containing chromic acid. In addition, studies have been made on the changes observed in P/C curves for alloys under non-oxidizing acids containing air, and reducing conditions. Improved performances of modified 18-8 steels containing copper or molybdenum are verified and explained. Certain auxiliary reactions such as replating of elements on the specimen surface, intercrystalline corrosion, and stress-corrosion must be recognized in order to properly interpret the P/C curves relative to the practical situation. Nevertheless, with this tool it is now possible to predict under which conditions an alloy is likely to show its best or worst properties.

D. L. McElroy

Solar Furnace in Nonferrous Research

Digest of "Nonferrous Research Uses Solar Furnace", by W. M. Tuddenham, *Journal of Metals*, Vol. 9, March 1957, p. 346-348.

A SOLAR FURNACE at the Kennecott Research Center in Salt Lake City, Utah, is providing a high-intensity source of pure heat under controlled conditions of pressure and furnace atmosphere in studies involving better and less costly methods of extracting and refining metals, especially copper.

A 60-in. diameter war-surplus searchlight parabolic reflector is used, and the searchlight base becomes a heliostat mount. The installation cost only $3400, exclusive of research time, of which $1400 was charged to materials and $2000 charged to labor.

The sun's rays are reflected from a movable flat mirror to a fixed flat mirror at the base of the parabolic reflector, thence to the parabolic reflector. At this stage, the rays are gathered and focused inside the sample chamber.

The parabolic mirror, front surfaced, is of copper with a rhodium plating. It has focal length of 25¾

(*Continued on p.* 184)

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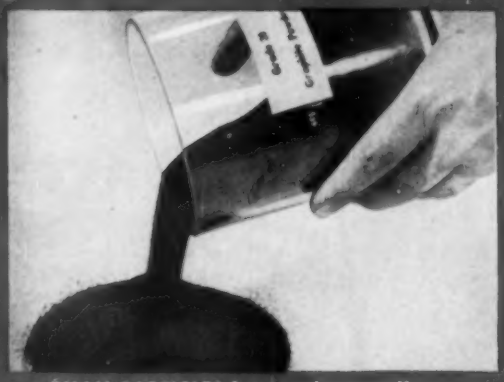
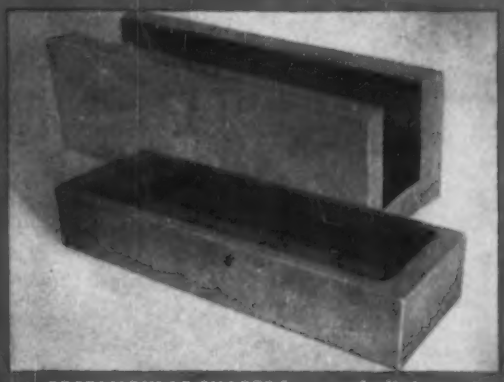
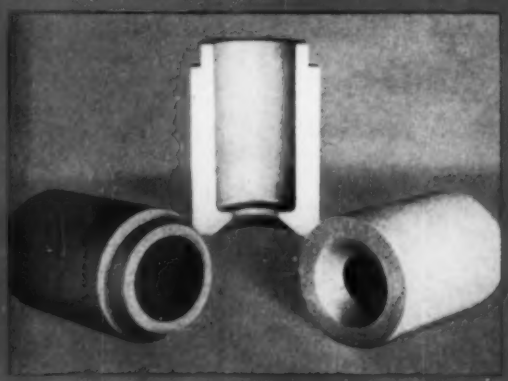


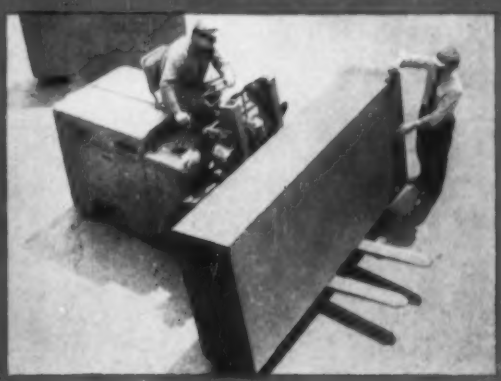
SMALL PARTICLES for powder metallurgy, lubricants, powder glazing and injection or inoculation of ferrous metals.



RECTANGULAR SHAPES for cupola linings, aluminum extrusion runout boards and cooling racks, sintering—brazing boats and trays.



CYLINDRICAL SHAPES for powder metal hot pressing molds, centrifugal casting molds and crucibles, resistance furnace elements.



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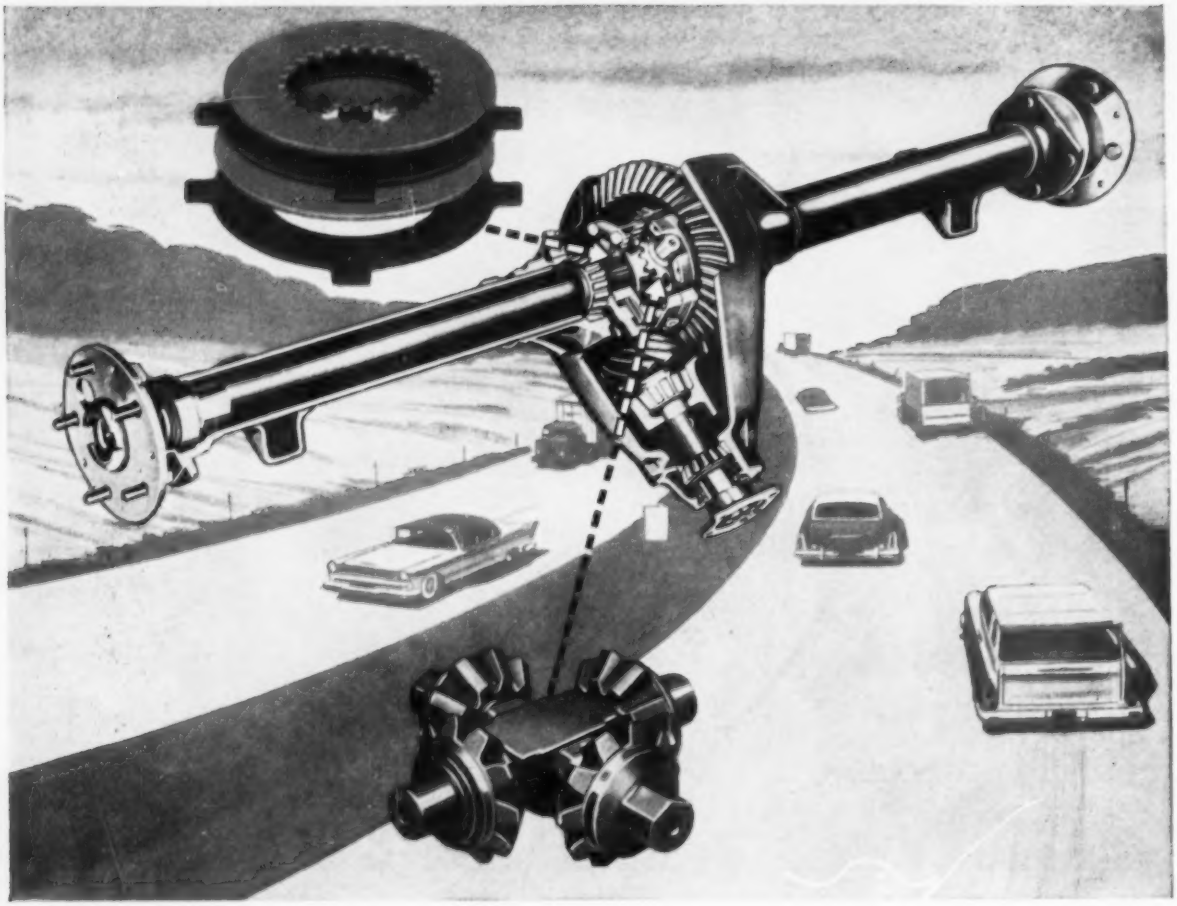

Modern passenger cars with increasing horsepower present problems in high speed stability and handling. The Powr-Lok differential, developed by the Dana Corporation, Toledo, Ohio, permits an automotive axle to transmit the greatest driving force to the rear wheel having the better traction.

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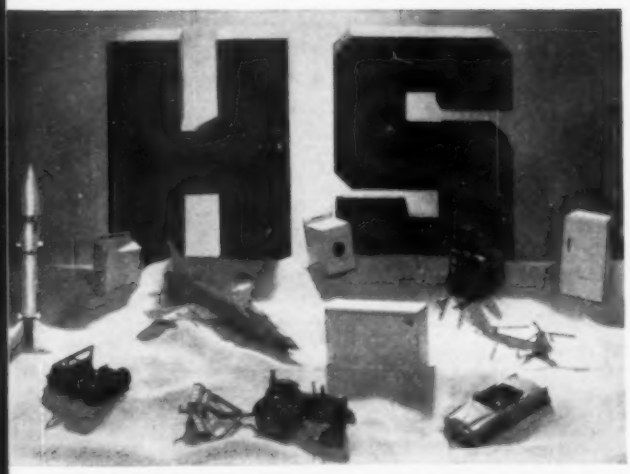

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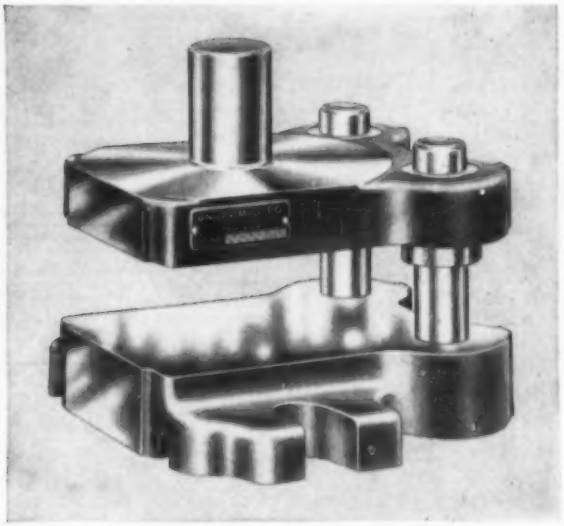

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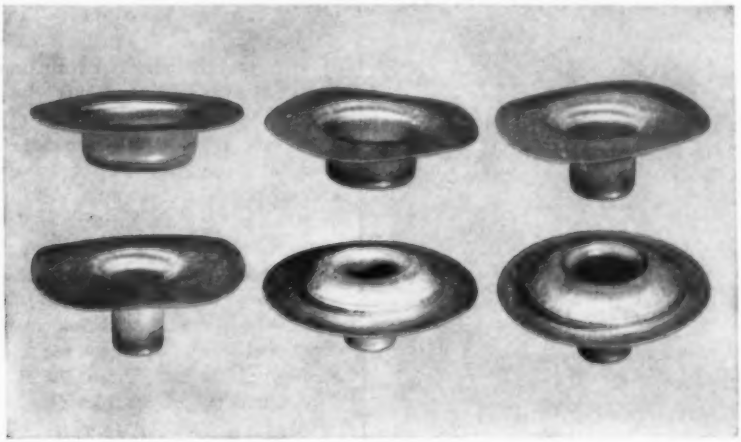

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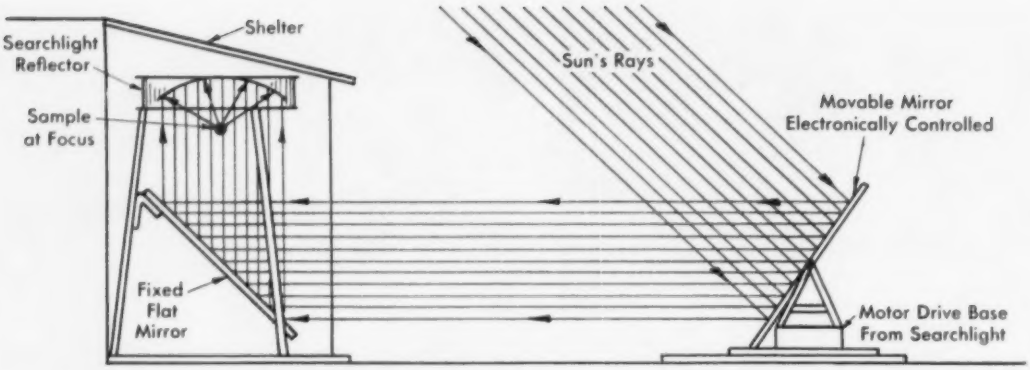

Fig. 1 — Diagram of Solar Furnace Installation. Temperatures above 5000° F. have been reached

in., effective concave surface of 19.6 sq.ft. and theoretical image diameter of 0.24 in. The two auxiliary reflectors are plate glass mirrors with electrolytic copper backing.

The heliostat uses reversible fractional horsepower motors. The motors are controlled by plate relays actuated by two photocells: One photocell controls elevation and the other the azimuth drive, permitting precision tracking of the sun. Temperature is controlled by a vertical slat blind across the mirror.

The sample chamber, a 4-in. diameter Pyrex cylinder, is supported on carbon blocks. A machined carbon block inside the chamber acts as a crucible. The cylinder may be supplied with protective atmospheres of various types, or operated under high vacuum.

Furnace temperatures are measured by fusing materials of known melting points, for example, melting magnesium oxide (melting point about 5000° F.). The unit will not melt rhenium, which has a melting point of about 5700° F.

Although the installation was completed only a year ago, a number of experiments have been successfully conducted on samples of fire-refined copper and on alumina.

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Fig. 2 — The Sample Chamber. The carbon block inside the chamber acts as a crucible

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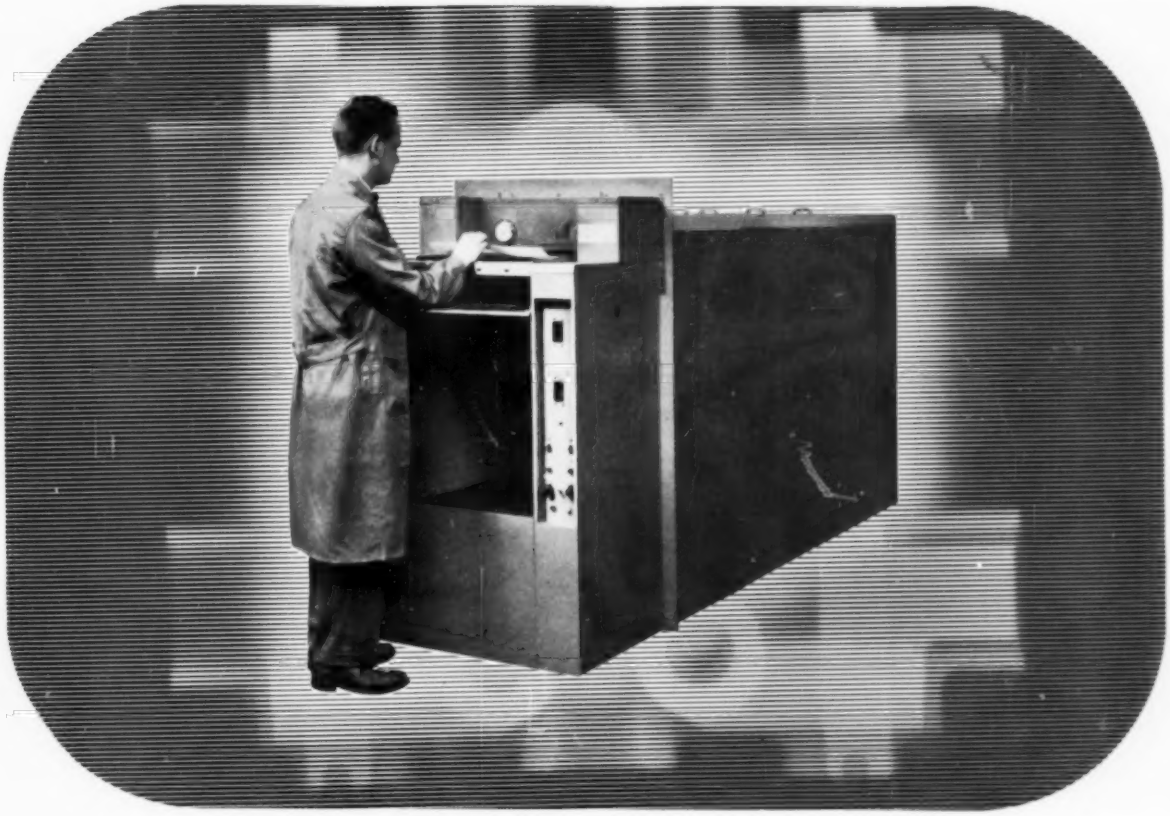

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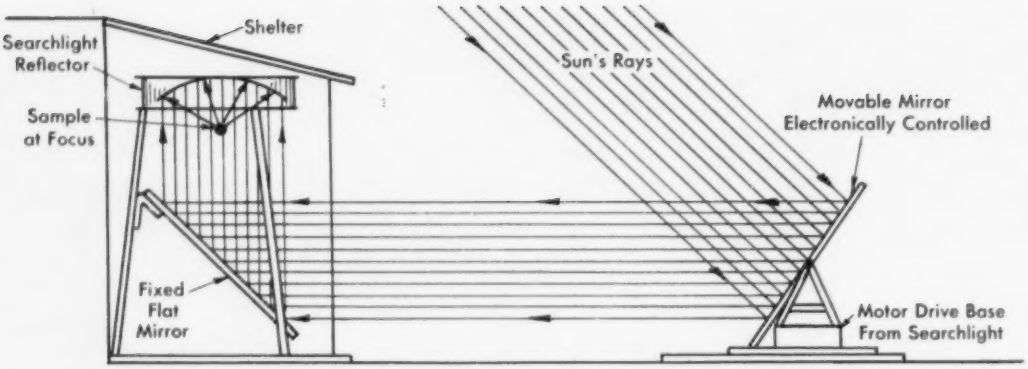

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The sample chamber, a 4-in. diameter Pyrex cylinder, is supported on carbon blocks. A machined carbon block inside the chamber acts as a crucible. The cylinder may be supplied with protective atmospheres of various types, or operated under high vacuum.

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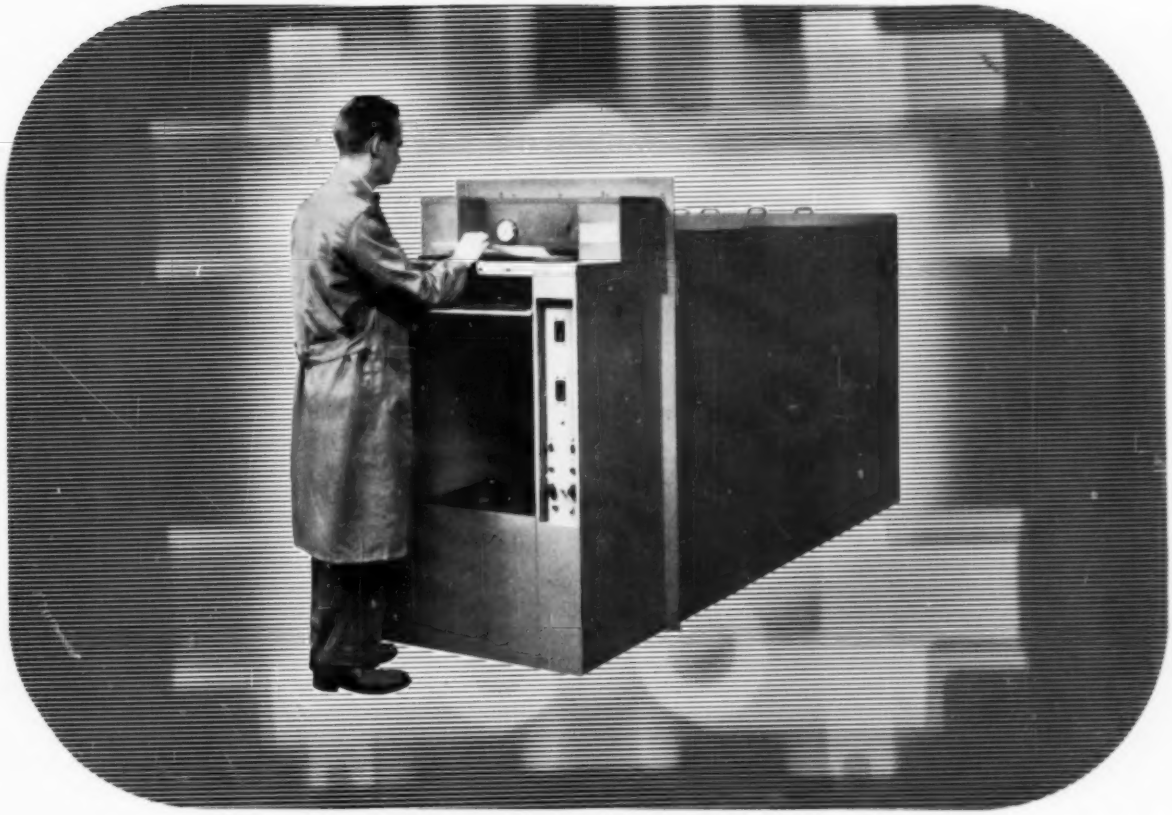

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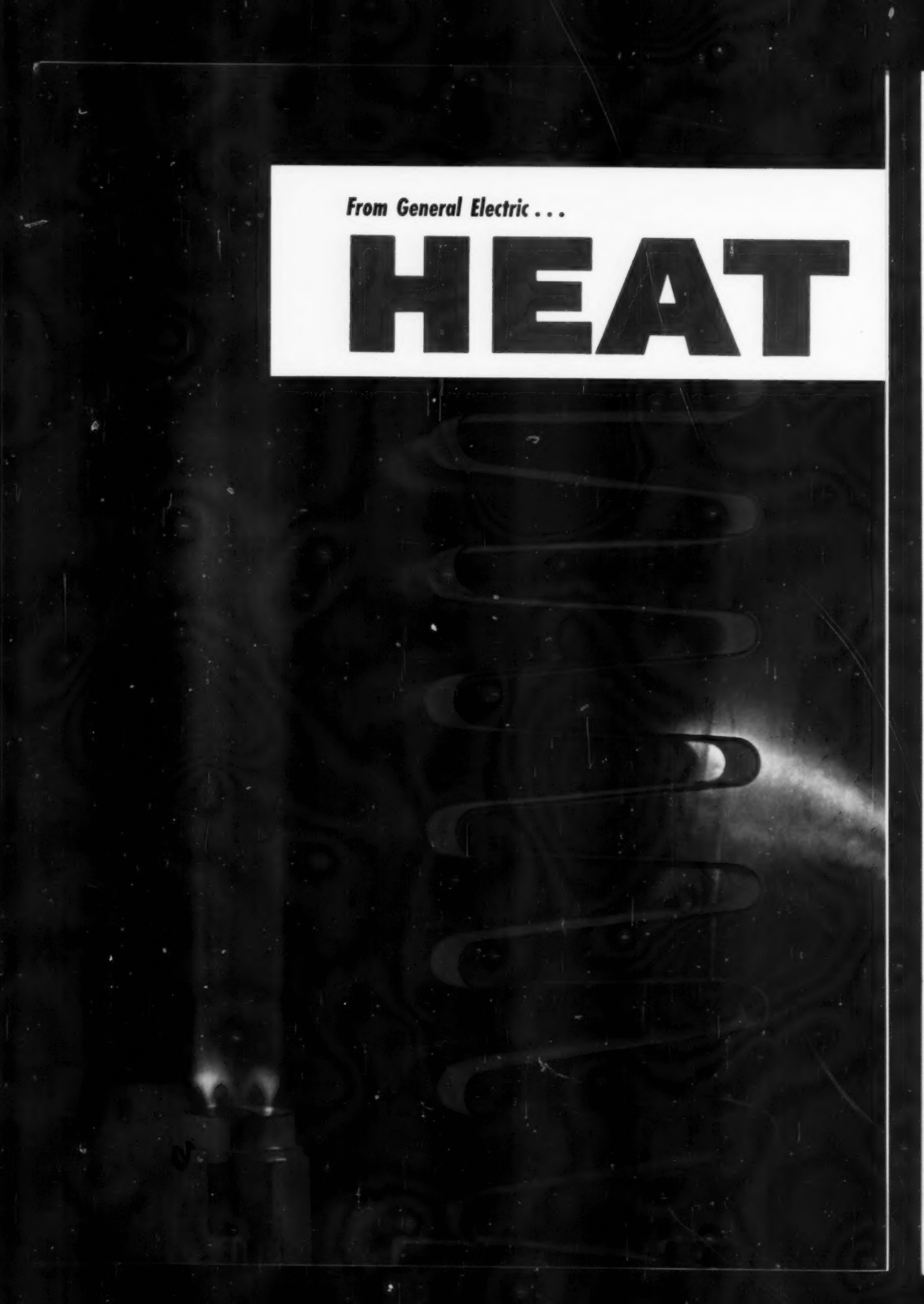
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And here's an example of what we mean by minimum spoilage. The electric bell furnace pictured below produced perfect wire on the first heat after start up, and has now operated for a full year without spoilage.

The gas-fired bell furnace on the right below was purchased to supplement a continuous pusher furnace. The flexibility provided by "batch" operation of the bell furnace produced real savings in time and money on small loads that require different temperatures and heat treatments.

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Call your General Electric heating specialist now. He'll show you how your investment in a gas or electric bell furnace system will pay for itself. Use the table below to see how you can use a bell furnace in your business.

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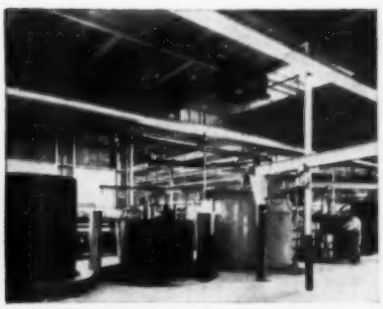
Applications	Castings	Forgings	Rod & Bar	Wire - Coils	Wire - Spools	Tube - Coils	Strip - Coils	Foil - Coils	Fabrications
Aluminum and Alloys	X	X		X	X	X	X	X	X
Copper and Alloys				X	X	X	X	X	X
Iron and Alloys	X	X	X	X					X
Stainless Steel Alloys			X	X		X	X		X
Magnesium and Alloys	X	X		X	X	X	X	X	X
Nickel and Alloys				X	X	X	X	X	
Silver and Alloys				X	X	X	X	X	X
Titanium and Alloys				X	X	X	X	X	X

Gas or electric bell furnaces from General Electric, symbolized by the illustration at the left, can handle all jobs shown in the table above.



This electric bell furnace, for example, produced bright, perfect wire on its initial run, and has now run one full year without a pound of spoilage.

This gas-fired bell furnace was purchased from G.E. to provide supplementary batch furnace capacity to handle special loads of copper wire at lowest cost.

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Impact Testing . . .

(*Continued from p. 77*)

Our first tests were made to evaluate the different notches. The four notch radii previously mentioned were tested at room temperature, 300 and 1000° F. As would be expected, the impact strength of the different grades increased with increasing notch radius. However, the rate of increase differed appreciably for the different steels. The oil hardening toolsteel (0-1) showed only a relatively small rise in toughness as the notch radius was increased. The gain in toughness was intermediate with the air hardening grade (A-2), while hot work steels (H-12, H-21) and the shock-resisting grade (S-5) had considerably greater impact strength with a 1-in. notch radius than in tests where the notch was ⅛ in. In further tests the ½-in. notch was used.

In Table I, the toughness of tungsten-base and molybdenum-base high speed toolsteels are compared at room temperature and 1000° F. The molybdenum-base steels, as a class, are tougher than the tungsten steels. Furthermore, the grades with cobalt (T-4, T-5, T-6 and T-8) are not as tough as those without cobalt. Table II shows the impact strength of other groups when tested with the ½-in. radius specimen. At room temperature, these various toolsteels decrease in toughness according to the following order: LaBelle HT, H-21, S-5, A-2, A-2 S, O-1, D-2, W-4, D-2 S and W-1. In Table III, the impact values are compared for a toolsteel (M-2) hardened by different methods.

The room-temperature toughness of M-2 oil quenched from 2225° F. is nearly independent of tempering temperature in the 900 to 11,000° F. range. Greater toughness, however, is observed when the steel is tempered at 600° F. This can be attributed to the lower hardness and the fact that the steel has not undergone secondary hardening. If M-2 is austenitized over a range of temperatures, and tempered at 1050° F., the best toughness is obtained from the lowest heating temperature (2075° F.) while the lowest toughness results from heating to 2275° F. This probably is caused by the lower carbide solution at the lower austenitizing temperatures. Thus, there is less carbon dissolved in the matrix, and the martensite is tougher. The toughness of M-2 increases gradually with increasing testing temperature; this rise is not dependent upon the initial heat treatment.

As is evident, this new test is useful in comparing different toolsteel classes, both at room and elevated temperatures. The optimum heat treatment for a given grade of toolsteel can easily be established.

BERYLLIUM, THE METAL

39 authorities are represented in this volume. Includes the importance of beryllium, reduction to metal, processing, fabrication, brittleness problems, corrosion, cermets and ceramics and health hazards. 700 pages — 6x9 — red cloth — $8.00. *Clip and send to ASM Technical and Engineering Book Information Service, 7301 Euclid Ave., Cleveland 3, Ohio.*

Austenite Transformation Behavior

Digest of "Some Observations on Ferrite-Carbide Aggregates in Alloy Steels", by E. S. Davenport, *Journal of Metals*, Vol. 9, May 1957, p. 677-688.

THE author reviews briefly the development of austenite transformation studies in recent years, noting that these studies have established that ferrite-carbide aggregates formed isothermally from austenite above the M_s temperature divide themselves into two broad categories of microstructure: the lamellar or pearlitic group, and the acicular or bainitic group. Between these two groups, in an intermediate temperature range, there is a transition from clear cut lamellar to acicular.

The experimental data presented deal with the microstructure and mechanical properties of isothermally produced ferrite-carbide aggregates in an alloy steel of eutectoid carbon content. These aggregates are designated lamellar, intermediate, and acicular depending on their microscopical appearance which, in turn, is related to the temperature range in which they form.

Nine isothermal transformation temperatures were selected for exploring the microstructural charac-

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Austenite . . .

teristics and mechanical properties of the isothermally transformed steel. Tensile strength, 0.2% offset yield stress, yield ratio, hardness, and microstructure followed a mutually consistent pattern.

Strength and hardness increased as transformation temperature decreased through the pearlite-forming range; in the intermediate temperature range there was a decrease in hardness and strength, followed by an increase as transformation temperature was lowered into the bainite forming range.

Reduction of area and toughness (measured by a standard Charpy V-notch specimen) increased as transformation temperature was lowered, then fell off appreciably in the intermediate range and increased again in the bainite-forming range, followed by a drop as the high-hardness bainite was reached. Elongation values decreased more or less regularly over the whole transformation temperature range investigated.

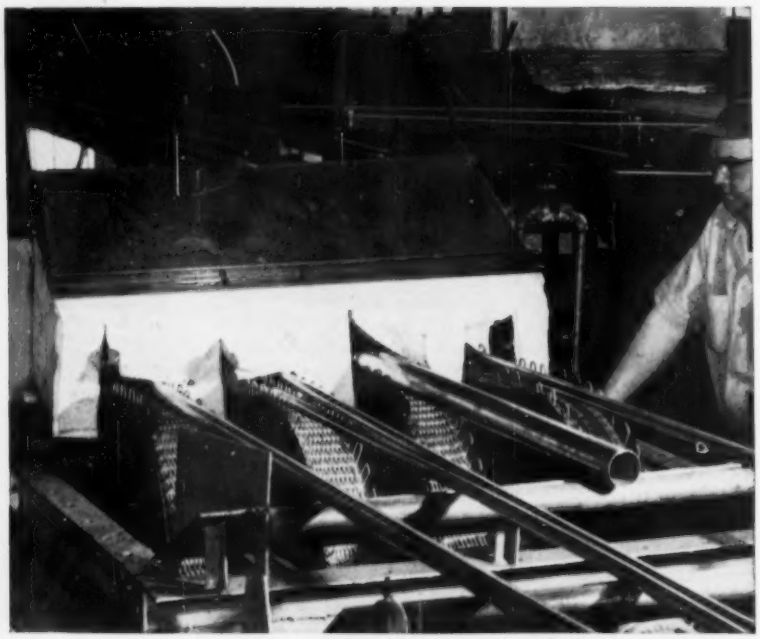
Thus, the mechanical properties of aggregates formed in the intermediate range are relatively inferior to those of fine pearlite and of bainite, and should be avoided for optimum properties.

The mechanical properties of the isothermally transformed steel were compared with the properties of the same steel fully quench hardened to martensite and tempered so as to encompass the same range of strength and hardness. In the comparisons, the properties were plotted against tensile strength – selected as a factor common to both the isothermal and quench and temper series. With the exception of lower bainite, tempered martensite exhibited consistently superior mechanical properties. Continuous cooling experiments were carried out to determine the effect of structures consisting of mixtures of tempered martensite and tempered direct transformation products, but with the particular steel involved, undesirable intermediate structures did not form in sufficient amounts to have an appreciably adverse effect on mechanical properties. This would not necessarily hold true for other combinations of carbon and alloying elements.

In the heat treatment of relatively large masses of steel, the formation of intermediate structures during cooling is an ever-present possibility. The future development of alloy steels would seem to depend upon a more searching analysis, and systematic study of the influence of carbon and alloying elements, both individually and in various combinations, upon the transformation characteristics and mechanical properties of these intermediate structures.

G. W. Brock

There is a "Right" Belt



Bright annealing of stainless steel tubing in controlled atmosphere . . . notice the loop guard edge on this Ashworth Belt.

...that will do the job better

Every product flow problem in processing is different. Make sure you have the "right" solution to your problem . . . consult an Ashworth engineer. Ashworth engineers have a precise knowledge of belt applications and can give you an intelligent analysis of your particular requirement.

Ashworth will engineer the "Right" belt do the job better.

Illustrated literature available

ASHWORTH BROS., INC., WINCHESTER, VIRGINIA

SALES ENGINEERS: Atlanta, Baltimore, Boston, Buffalo, Charlotte, N. C., Chicago, Cleveland, Dallas, Detroit, Fall River, Mass., Greenville, S. C., Louisville, New York, Philadelphia, Pittsburgh, Rochester, St. Louis, St. Paul, Tampa, Canadian Rep., Peckover's Ltd., Toronto, Montreal.

ZIRCONIUM

Thirty-seven leading authorities discuss this key metal from ore dressing through reduction, preparation of powder and sponge, to its chemistry and final application. 354 pages–6x9–illustrated–red cloth–$7.50. *Clip and send to Technical and Engineering Book Information Service, 7301 Euclid Avenue, Cleveland 3, Ohio.*

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Now . . . one grade of trichlor does both

Whether you clean a rocket or degrease a gear, you can now use Nialk® metal degreasing grade trichlorethylene as your cleaning agent.

This grade of Nialk meets rigid government and industry standards for solvents used to clean rocket and missile components. It leaves little or no residue when it evaporates. At the same time, it keeps the above-average chemical stability needed for vapor degreasing.

The savings in this twofold use of one grade of trichlor can be readily seen. Now you can:

Cut your inventory and make your buying easier.

Avoid errors. No one can pick the wrong drum when you're buying just one grade of trichlor.

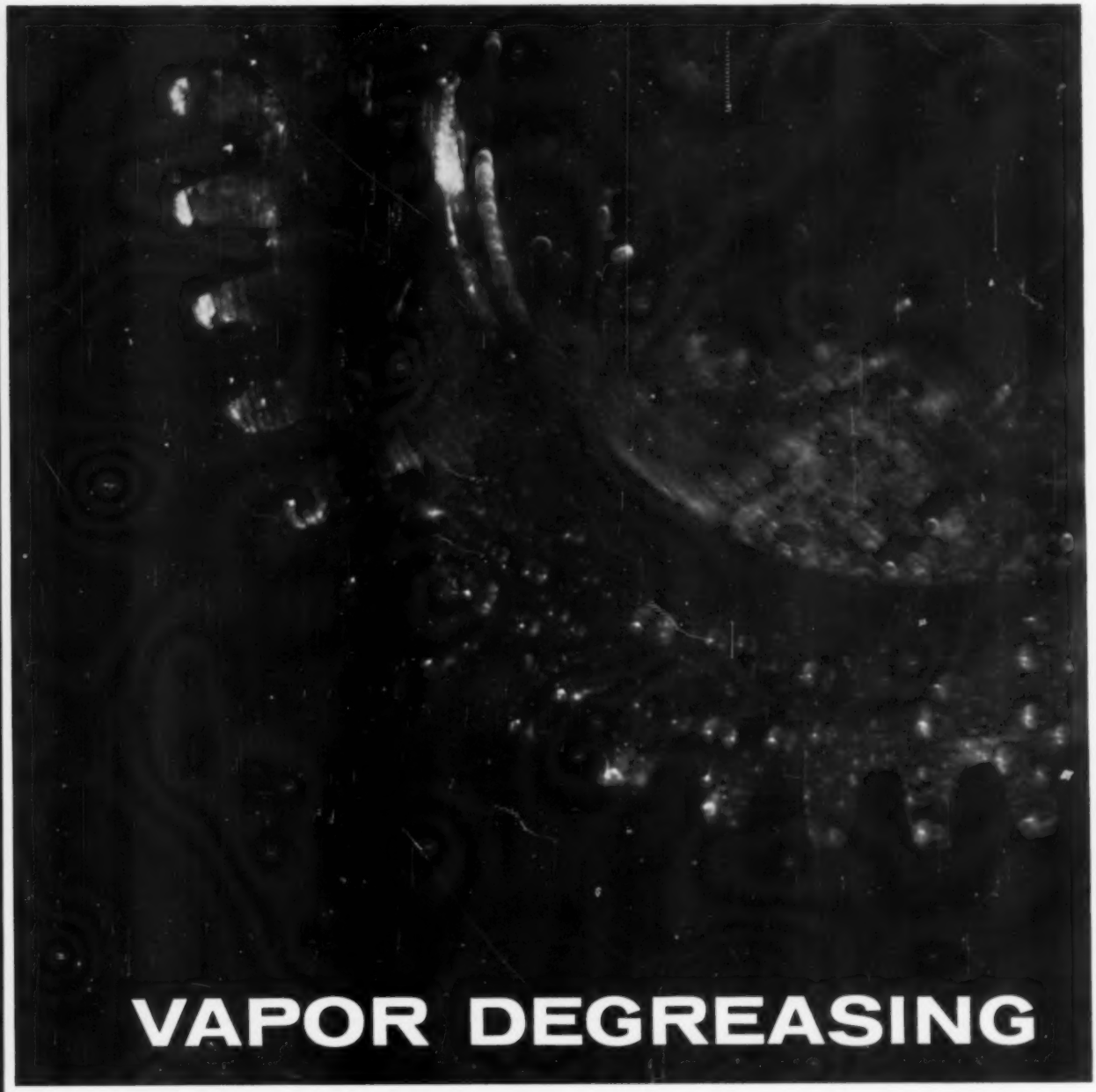
Make your materials handling easier.

Help end your disposal problems. Usually you can use the Nialk trichlor from your flushing operation in your vapor degreasing operation without distilling, or the solvent can be recovered and used again and again.

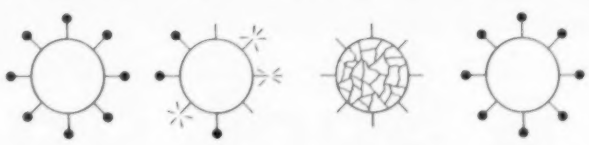
STABILITY WITH PSP

You get **psp** too, when you ask for Nialk trichlorethylene. **psp** is "**p**ermanent **s**taying **p**ower," the ability of the stabilizer to keep from wearing out.

You can get more information on this metal degreasing grade of Nialk trichlor. Just write for specifications and data.



MORE AND BETTER DEGREASING WITH **PSP**



1. Trichlor is protected by stabilizer against heat, air, light, moisture, acids, and active metals.

2. Ordinary stabilizers wear out during use, making it necessary to titrate and add fresh stabilizer.

3. A sour solvent can even stain metals instead of cleaning them; affects bath operation, too.

4. Nialk has psp . . . permanent staying power. Always gives you full protection. Never goes sour.

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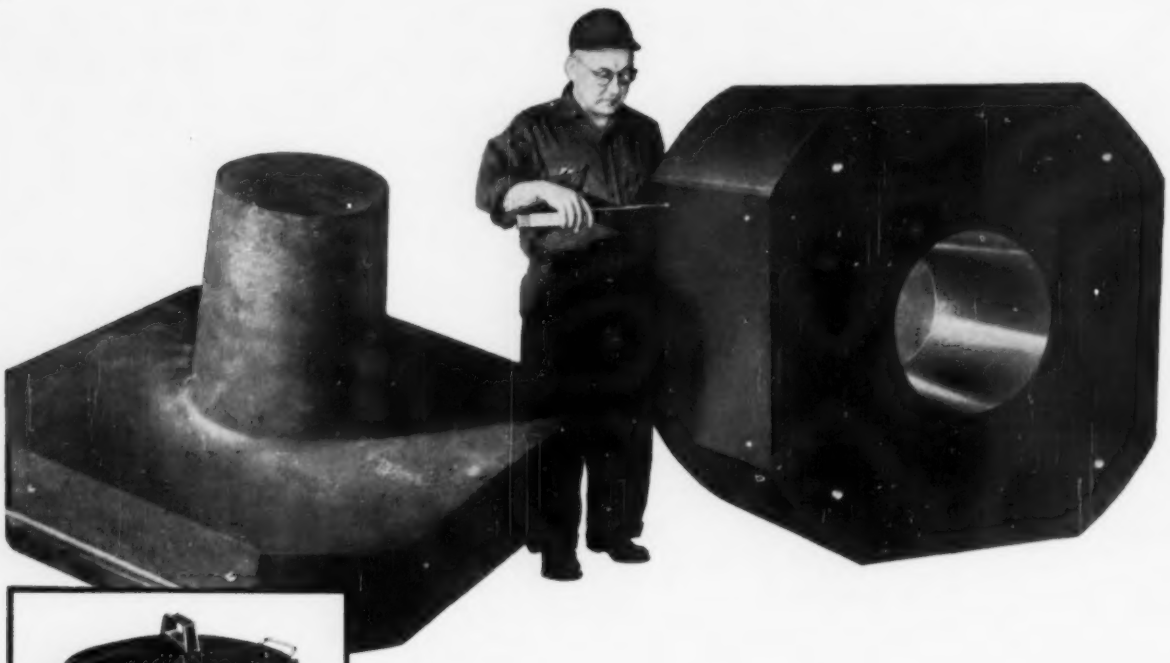
Sales Offices: Chicago, Detroit, Los Angeles, New York, Niagara Falls, Philadelphia, Tacoma, Worcester, Mass.

HOOKER CHEMICALS PLASTICS

In Canada: Hooker Chemicals Ltd., North Vancouver, B.C.



USE FINKL BLOCKS FOR DIES AND MOLDS...

Impressions are our business!

These two rough machined blocks were furnished from Finkl electric furnace steel. When finish machined they were used by Columbus Plastic Products, Inc. of Columbus, Ohio, to mold their 24-gallon polyethylene Lustroware Trash Cans such as the one shown at the left. The four foot square blocks weighed 21,996 pounds when shipped.

This was a large mold, but regardless of size, the advantages of Finkl products are many:

- Finkl electric furnace steels are especially balanced in composition to provide uniform hardness and a high polish which is reflected on every plastic part.
- Relatively high tempering temperature promotes ductility and eliminates residual stresses.
- Finkl special steels have Special Machining Quality which appreciably reduces sinking time without impairing any quality factors.
- Finkl special steels cover the full usable hardness range from Temper H (477-444 BHN) to Temper 4 (293-269 BHN).
- Finkl special steels are available in all sizes, and tempers to handle virtually any die or molding requirement.

These advantages can mean savings to you in time and money. Call a Finkl representative the next time you are planning forming production whether it is molds for plastics or die blocks for closed die forgings.

DIE BLOCKS · FORGINGS · HOT WORK STEELS · ELECTRIC FURNACE STEELS

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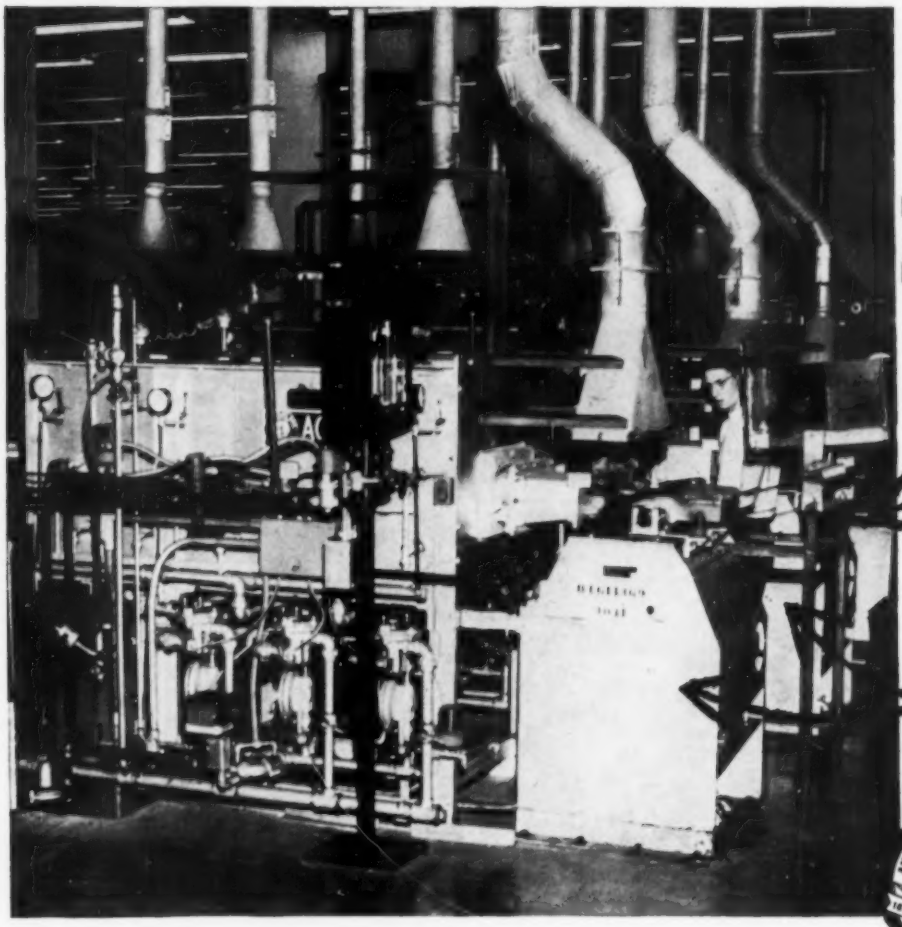
PRODUCTION HEAT TREATING



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furnaces

80 YEARS OF PIONEERING 1878 1958 AMERICAN GAS FURNACE CO. ELIZABETH, N. J.

IBM, at their new Lexington, Kentucky plant, installed three AGF Model 238 Reciprocating Furnaces and Automatic Quenching Tanks to assure an efficient, carefully controlled flow of dependable and uniform light case carburizing and clean hardening of IBM Electric Typewriter parts to meet the most exacting standards.

These three controlled atmosphere reciprocating shaker hearth furnaces, installed at IBM, are only one model of a very complete line of AGF furnaces designed to meet every specific and varied need for continuous, economical clean hardening of parts of all sizes.

Write for Catalog 607 for full details on the AGF furnaces to cut your costs and increase your production volume.

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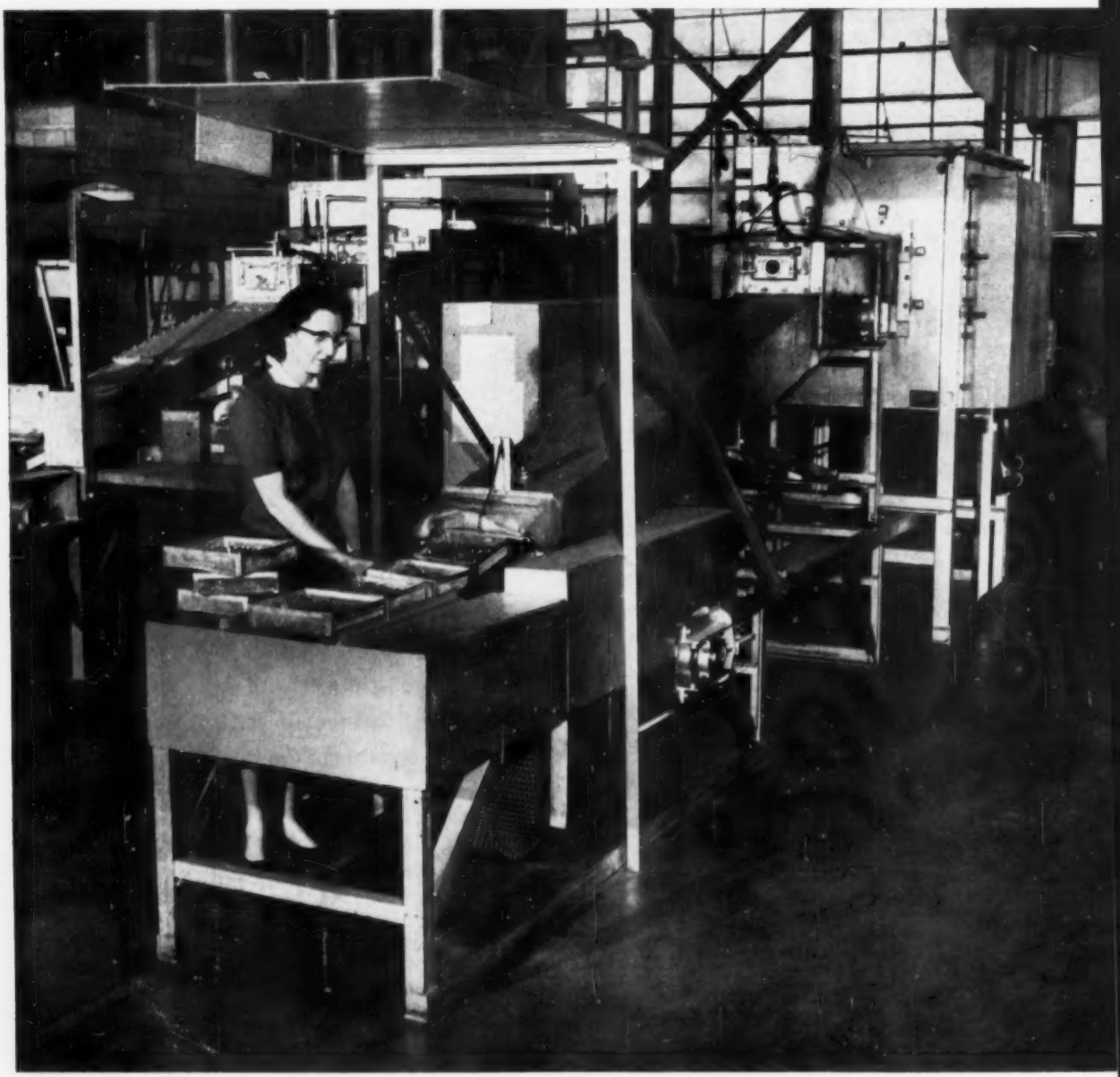
HOW ELECTRONIC TUBE CRITICAL HEATING *WITH LOW MAINTENANCE*



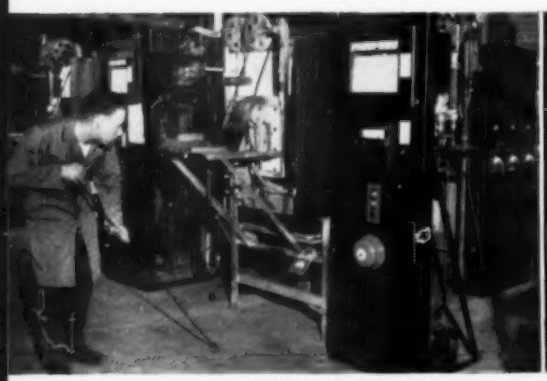
TWO OF THE ELECTRIC FURNACES, manufactured by C. I. Hayes, Inc., 800 Wellington Avenue, Cranston, R. I., are shown above. GLOBAR heating elements are used to insure the accurate control and clean heat required in critical heat treating and brazing operations.

PLANT SOLVES PROBLEM... *COSTS*

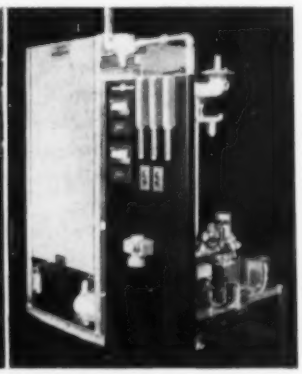
Westinghouse Electric Corporation, Electronic Tube Division, uses electric furnaces with controlled atmosphere generators *(ammonia dissociators)*... both equipped with GLOBAR® electric heating elements

Hydrogen heat treating and brazing of critical electronic tube components in the 600 C—1200 C range are carried out in one Hayes 5" x 7" Pusher and two 12" belt conveyor electric furnaces at the Westinghouse Power Tube Manufacturing Department, Horseheads, N. Y. The usual materials used are copper, steel and nickel of exacting specifications which must be carefully maintained. The work produced by all three furnaces is bright and clean. In addition, the pusher furnace can be used with a retort box under high gas flow to produce annealed magnetic alloy parts. Controlled atmospheres for all furnaces are provided by Hayes Generators.

GLOBAR silicon carbide electric heating elements are used in both the furnaces and an atmosphere generator. "We have found from experience over several years that these furnaces equipped with GLOBAR elements do a fine job and require little maintenance," says Westinghouse. "They perform satisfactorily in maintaining a range of critical temperatures."



ATMOSPHERE GENERATORS (ammonia dissociators), used in conjunction with the furnaces, are also a Hayes product. Here again, GLOBAR silicon carbide elements are used to supply closely controlled heat.



LATEST TYPE "IGL" Hayes Protective Atmosphere Generator, using the new GLOBAR Delta elements. Features include easier removal of catalyst, improved instrument layout and precise acting carburetor for control of air-gas ratio.

The ECONOMIC advantages of electric heat:

There are many reasons why GLOBAR Delta silicon carbide elements are economical as well as dependable, clean, safe, and quiet. There is no fire or explosion hazard, and exhaust and fuel storage facilities—and costs—are unnecessary.

Only with electric heat can heating cycles be precisely duplicated and temperatures accurately controlled, independent of the atmosphere. Product quality is improved and rejects sharply reduced. Electric furnaces and kilns are compact and space-saving. They can be located in the production line, thereby accelerating production and reducing costs per unit of product.

The investigation of an electric heating application should include more than the comparison of BTU and electricity costs. Lower furnace maintenance and operating cost, plus full utility of BTU input, will frequently more than offset a fuel cost differential.

Installation of Delta elements is simple, and element replacement is accomplished quickly without cooling the furnace or interfering with production.

Typical applications for GLOBAR Delta elements include furnaces and kilns for: heat treating, forging, sintering, brazing, annealing, melting, assaying, roasting, laboratory and research: and ceramic firing of ferrites, titanates, steatities, refractories, electrical insulators, grinding wheels, whiteware, pottery and tile.

Find out how your operation could profit by using GLOBAR Delta silicon carbide electric heating elements. Your furnace builder can supply you with full details. The Carborundum Company, Refractories Division, Globar Plant, Dept. MP59, Niagara Falls, New York.

CARBORUNDUM

Registered Trade Mark

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HONEYWELL INDICATING TEMPERATURE CONTROLLER

. . . designed for industrial applications

The new Honeywell T654A is a rugged, dependable, yet modestly priced indicating temperature controller designed specifically for industrial use. It includes these features:

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- Sensitive, liquid-filled thermal system.
- Complete case and tubing compensation for ambient temperature.
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Honeywell

First in Control

KNOW YOUR ALLOY STEELS . . .
This is the first of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

What is an Alloy Steel?

Here is an easy definition to remember: An alloy steel is a grade of steel in which one or more alloying elements have been blended to give it special properties that cannot be obtained in carbon steel.

Or, here is the metallurgical definition: An alloy steel is one in which the maximum specified content of alloying elements exceeds one or more of the following limits—

Manganese, 1.65 pct; Silicon, 0.60 pct; Copper 0.60 pct

or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized commercial field of alloy steels: aluminum, boron, chromium up to 3.99 pct, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other element added to obtain a desired alloying effect.

As a rule, alloy steel is more difficult to make than carbon steel. There are more elements to be kept within specified ranges and, in general, the ranges of the alloying elements are comparatively narrow; hence the mathematical chances for producing off-heats are correspondingly increased. Moreover, most alloy steels require special reheating and cooling to prevent such imperfections as flaking and cracking.

Surface imperfections must be removed from the billets by scarfing, chipping, or grinding. More exacting methods of testing and inspection are necessary to insure uniformity.

Where Does It Pay To Use Alloy Steel?

Generally speaking, it is advisable to use alloy steel when more strength, ductility, and toughness are required than can be obtained in carbon steel in the section under consideration. Alloy grades should also be used where specific properties such as corrosion-resistance, heat-resistance, and special low-temperature impact values are needed.

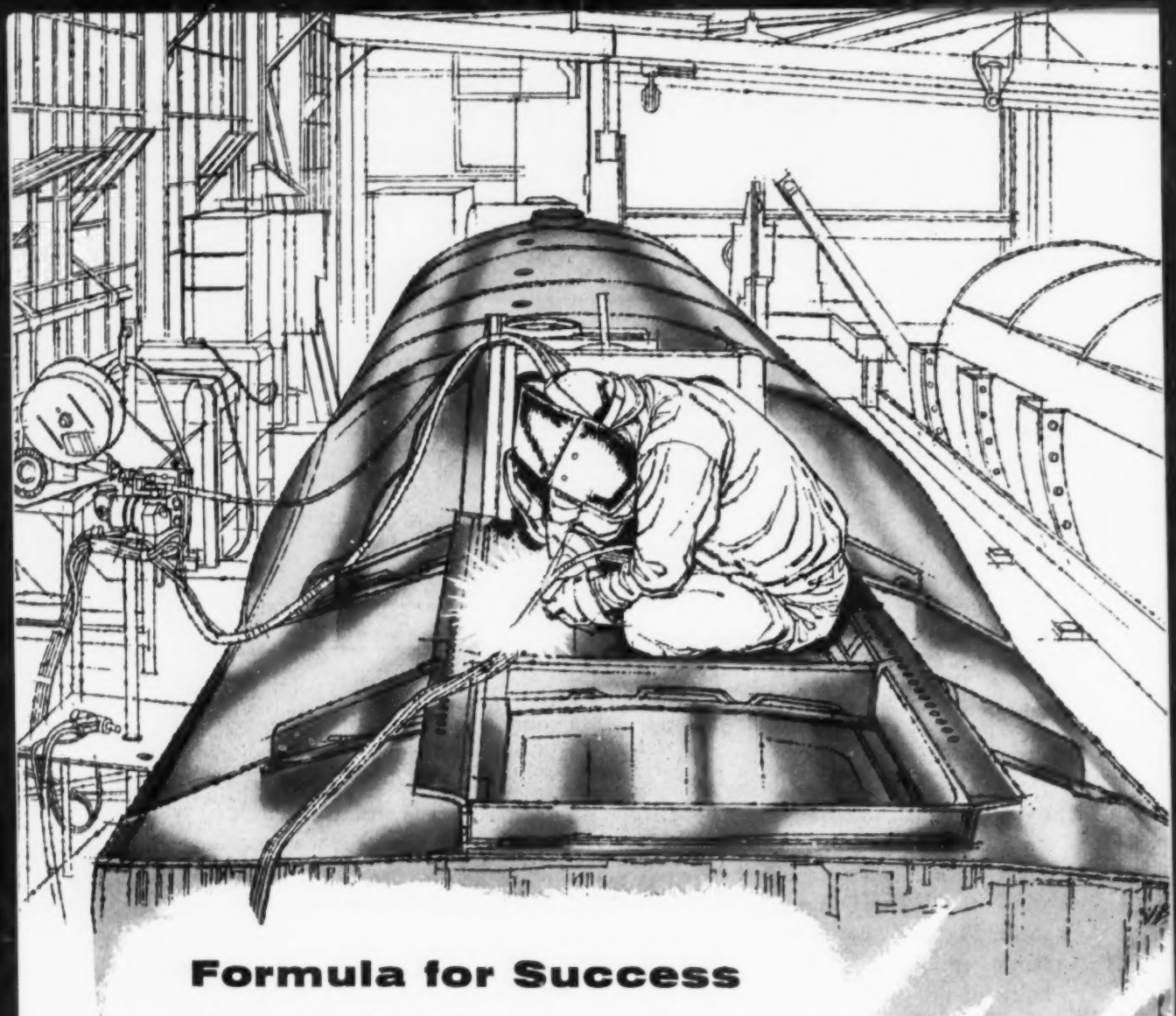
In some cases it requires considerable study to determine when and how to use a particular alloy steel to advantage in a product. Where there is any problem or doubt concerning its use, Bethlehem metallurgists will gladly give impartial advice on analysis, heat-treatment, machinability, and expected results.

In addition to manufacturing all AISI standard alloy steels, this company produces other than standard analysis steels and the full range of carbon grades.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL



Formula for Success

The formulation of a stainless steel alloy requires as much precision as any chemical compound. All the care exercised in the selection of a particular alloy can be nullified by variations in the analysis specified.

During fabrication, for example, slight differences in chromium-nickel: carbon ratios can cause changes in microstructure which lead to early failure.

That's why it is safer to specify J&L Consistent Quality Stainless Steel. J&L leads the industry in melt shop standards for stainless steel—the point where quality starts, **and longer service life begins.**

Plants and Service Centers:
Los Angeles • Kenilworth (N. J.) • Youngstown • Louisville (Ohio) • Indianapolis • Detroit

STAINLESS
SHEET • STRIP • BAR • WIRE

Jones & Laughlin Steel Corporation • STAINLESS and STRIP DIVISION • Box 4606, Detroit 34

CROWD

is synonymous with Metal Show. And crowd means people. Thousands upon thousands of metals executives. More prospective metalworking buyers in one building than you'll ever find anywhere else. And, ironically, they come to you. You aren't giving precious time toward travel. You aren't sitting in a lobby. You are where they are. You are where the buying crowd is. Pity the salesman on the road during Metal Show time—no one to talk to. All the important people have become a crowd.

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Take me to your buyer ...I'm the leader!

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*Also Tempil° Pellets and Tempilaq° (liquid form)

Tempilstik°—a simple and accurate means of determining preheating and stress relieving temperatures in welding operations. Widely used in all heat treating—as well as in hundreds of other heat-dependent processes in industry. Available in 80 different temperature ratings from 113°F to 2500°F... $2.00 each.

Send for free sample Tempil° Pellets. State temperature desired... Sorry, no sample Tempilstiks°.

Most industrial and welding supply houses carry Tempilstiks°... If yours does not, write for information to:

MARKETING DIVISION

Tempil° CORPORATION

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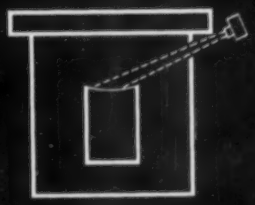
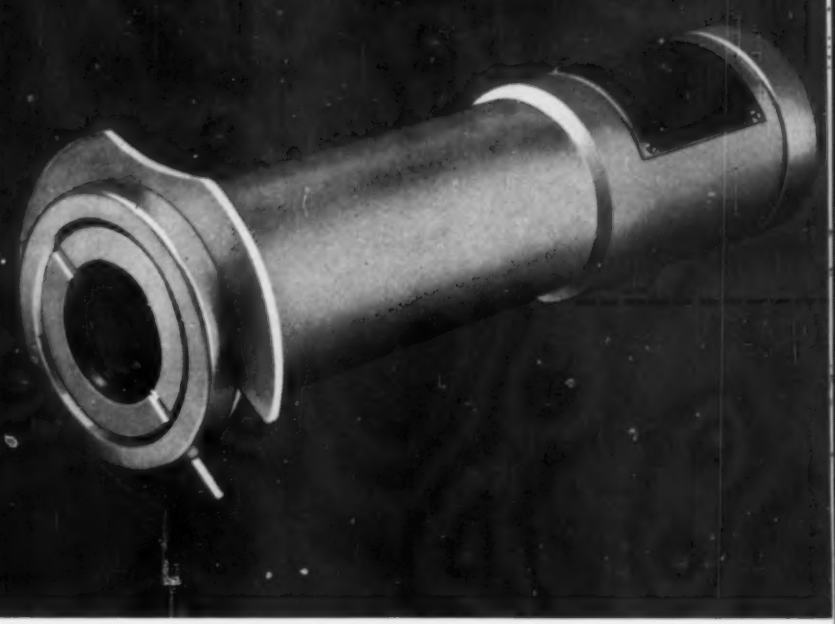
... HEAT-TREATING - 1960 ...
CAMBRIDGE METAL-MESH BELTS are the answer to the big problems you'll face in the competitive '60's—tighter operating costs, higher production and consistent quality.
Continuous movement of products through heat-treating operations, as well as quenching, washing and drying, speeds up production and cuts costly manual handling.
Heat, liquids or gases flow through the belt and around the product for fast, thorough processing... assuring uniformly high quality.
Superior belt design and manufacturing techniques mean longer belt life, fewer repairs, lower operating costs.
Belts can be made heatproof or acidproof—in any mesh, weave, metal or alloy—with any side or surface attachments.
Call your Cambridge Field Engineer now. He'll be glad to discuss any aspect of Cambridge Belts—from manufacture to installation and service. Look in the yellow pages under "Belting, Mechanical". Or, write for FREE 130-PAGE REFERENCE MANUAL.
The Cambridge Wire Cloth Co.
Department B • Cambridge 5, Md.
Manufacturers of Wire Cloth, Metal-Mesh Conveyor Belts, Wire Cloth Fabrications



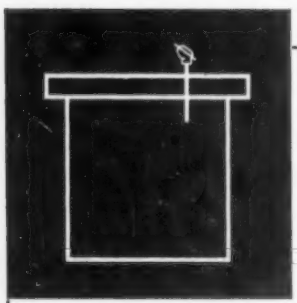
RADIAMATIC RADIATION DETECTORS

For measuring temperatures to 7000 F.

Measure "problem" temperatures with Radiamatic detectors. Use them to measure the temperature of moving objects without physical contact . . . or for representative temperatures over large areas. These fast-acting detectors are available in many models including a small-target unit with ¼" aperture for temperatures up to 7000 F. You'll find Honeywell engineering assistance extremely valuable in their application.



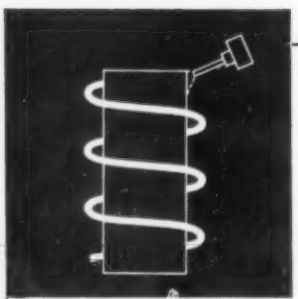
Honeywell has the tools to Solve your high-temperature



THERMOCOUPLES

For sensing temperatures in the area of 4000°F.

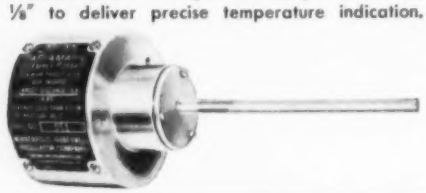
New experimental Honeywell thermocouple materials like Rhenium-Molybdenum and Rhenium-Tungsten measure temperatures as high as 4000°F. Great diversity of elements, heads, extension wire, protecting tubes and accessories permits you to select the thermocouple which fits your application *exactly*.

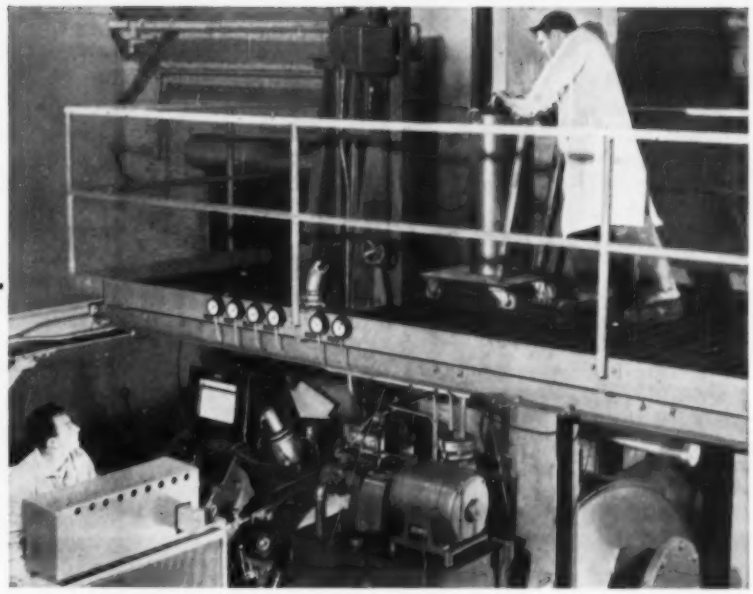


SAPPHIRE RODS

For measuring temperatures to 3600°F.

Sapphire rods are used as lens replacements in *Radiamatic* pyrometers. They provide accurate high-temperature measurement where such measurement previously could not be made by conventional means. For example, sapphire rod detectors can be inserted between the coils of an induction heater or "sight" on a target as small as ⅛" to deliver precise temperature indication.





CONTINUOUS MELT RECORD AT 3000°F with the *Radiamatic* unit (arrow) attached to a Stokes semi-continuous vacuum furnace at Allegheny Ludlum Steel Corporation, Watervliet (N.Y.) Works. Honeywell engineers worked with Allegheny-Ludlum to provide a constant record of vacuum furnace temperature—without calibrating rheostats or other complicated adjustments. The *Radiamatic* radiation pyrometer and engineering know-how solved this seemingly insoluble problem.

measurement problems

Precise measurement of high temperatures is almost an art. Working effectively with temperatures over 2800°F. calls for an intimate knowledge of materials and methods that can be gained only from broad experience. Through this experience—in every aspect of metal processing—Honeywell has developed special techniques and equipment for measuring high temperatures.

Honeywell offers you the sum total of this experience in engineering assistance and an all-inclusive line of instruments, special-purpose measuring devices, thermocouples and accessories. Combined, these tools and techniques can give you better products and day-to-day production economies.

Your nearby Honeywell field engineer will be glad to discuss your requirements. Call him today . . . he's as near as your phone.

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Honeywell

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When you specify **Allis-Chalmers Induction Heaters—**

Expect the EXCEPTIONAL

The speed, convenience, cleanliness and economy of induction heating are spectacular in themselves. Yet Allis-Chalmers actually enhances those advantages with a practical approach to application.

- **Test runs on your product** made in the A-C laboratory provide specific application data.
- **Special fixtures,** coils and work handling equipment designed and manufactured by A-C customize and streamline your operation.
- **Factory-supervised installation** gets your Allis-Chalmers induction heater off to a good start.
- **Periodic checkup and emergency maintenance service** supplied by regional offices keep your induction heater profitably productive — assure complete dependability.

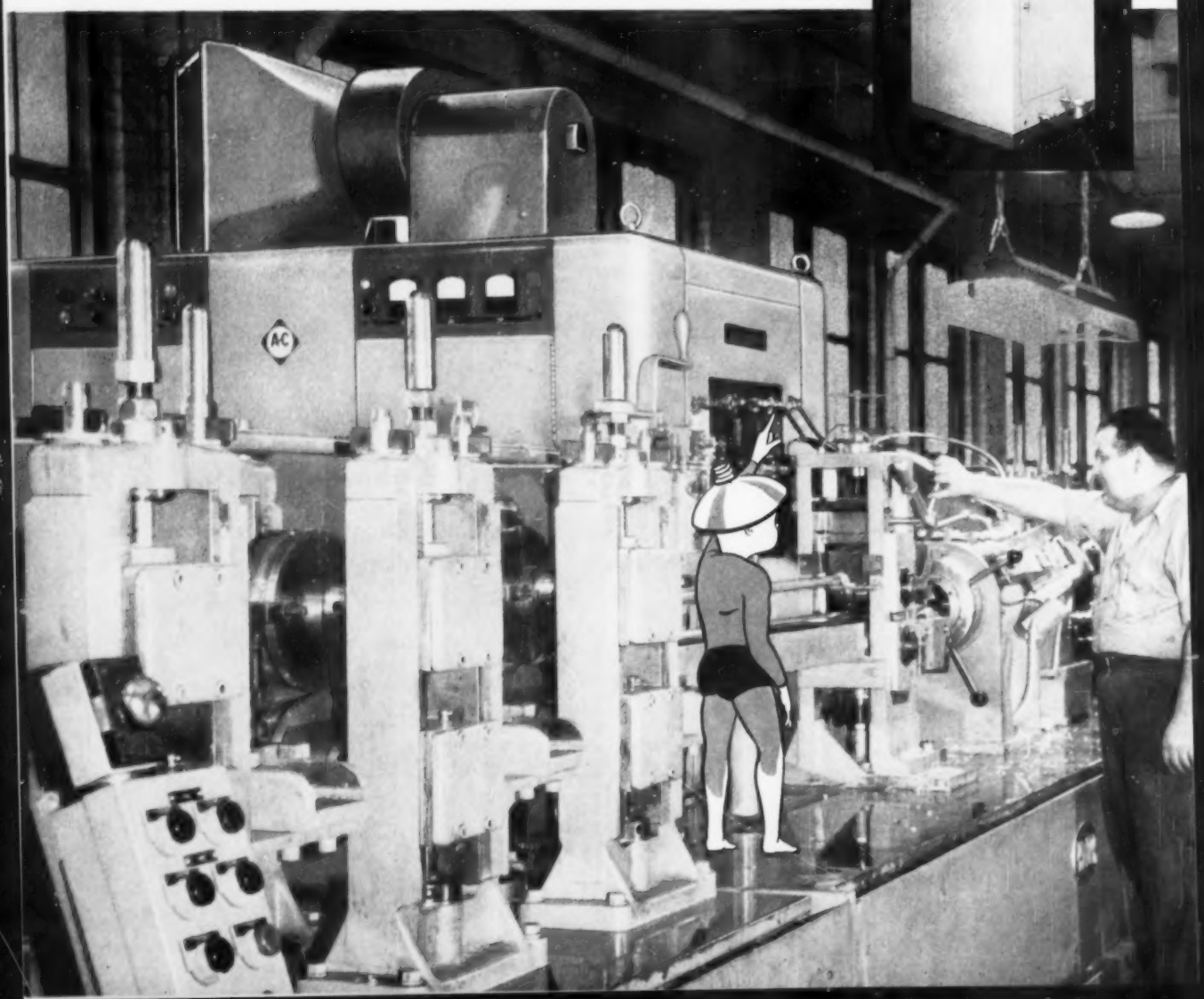
If your job is one of brazing, soldering, hardening, annealing, or heating for forging, induction heating can do the job better, faster and at less cost. For double assurance of complete satisfaction, consider both the quality of the heater and the services of the manufacturer — insist on Allis-Chalmers. *See your A-C representative or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.*

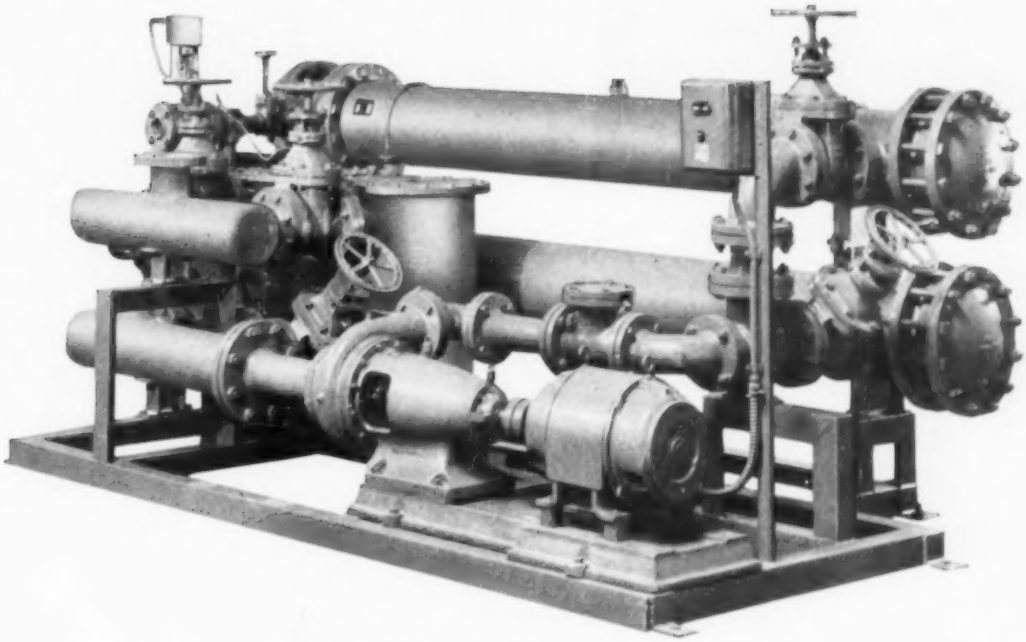
Standout performance assured by EXTRA services

Plan to stay ahead... MODERNIZE!

ALLIS-CHALMERS

A-1021.GI



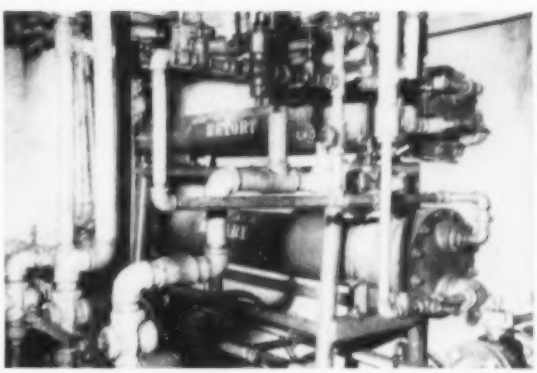


CONTROLLED QUENCHING FOR CONTROLLED QUALITY...JOB-TAILORED BY B&G

B&G Quenching Systems help you maintain uniform quality of heat-treated parts—cut substandard rejects—by accurately controlling the temperature of quenching oil.

For batch or continuous quenching, a job-tailored B&G Quenching System circulates oil at high velocity and turbulence through the quench tank; strains it, cools and recirculates it—and holds it at specified temperature throughout the quench period. Result: Uniform quality parts.

However large or small your heat-treating operation may be, B&G can furnish a self-contained, fully automatic quench oil cooling unit. It will arrive ready to go to work—your only responsibility is to connect to the quench tank and water lines. (The system is movable, too, in the event of layout changes.) Or, if you prefer, you can purchase the components and assemble them on the job. Either way, our engineering department's help is always available.



B&G Controlled Oil Quenching System helps maintain uniform quality of heat treated parts in Chrysler Corporation Automatic Transmission Plant, Indianapolis, Indiana.

Write for this readable, informative combined Catalog and Selection Manual on B&G Self-Contained Oil Coolers.

Hydro-Flo

OIL QUENCHING SYSTEMS

Reg. U.S. Pat. Off.

BELL & GOSSETT COMPANY

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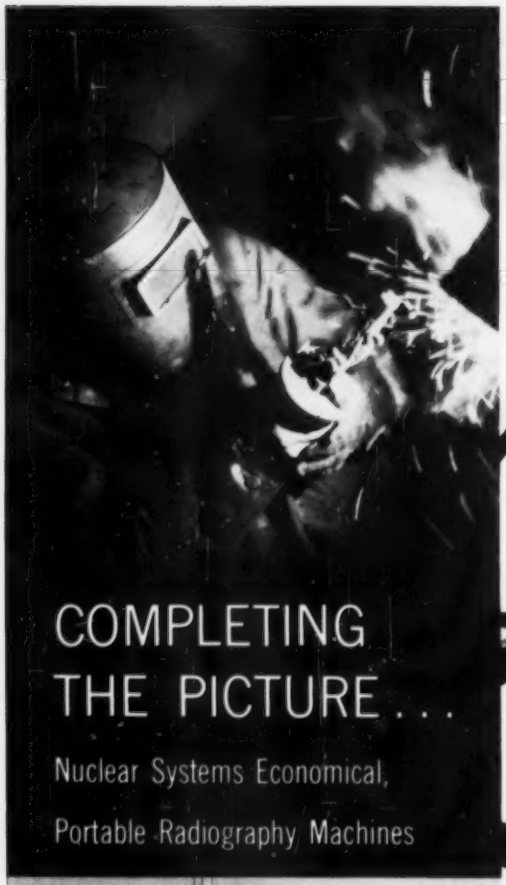

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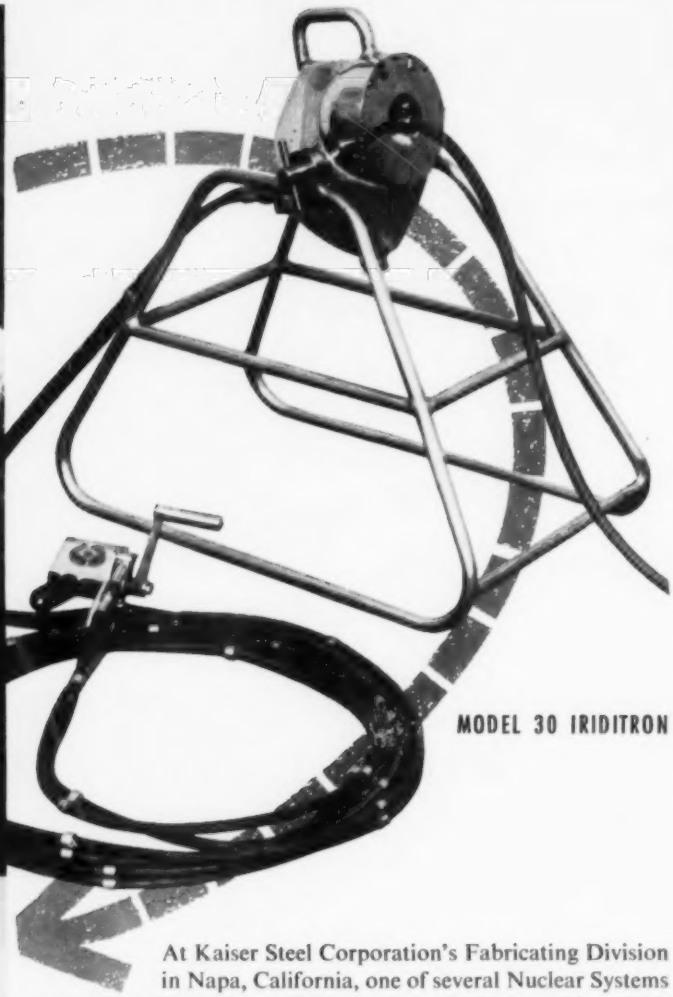

MODEL 30 IRIDITRON

At Kaiser Steel Corporation's Fabricating Division in Napa, California, one of several Nuclear Systems portable radiography machines is brought into position. This man is using a light, easily carried Model 30 with an Iridium 192 source to spot-check plate welds on the bow section of a steel barge. The steel is a half inch thick.

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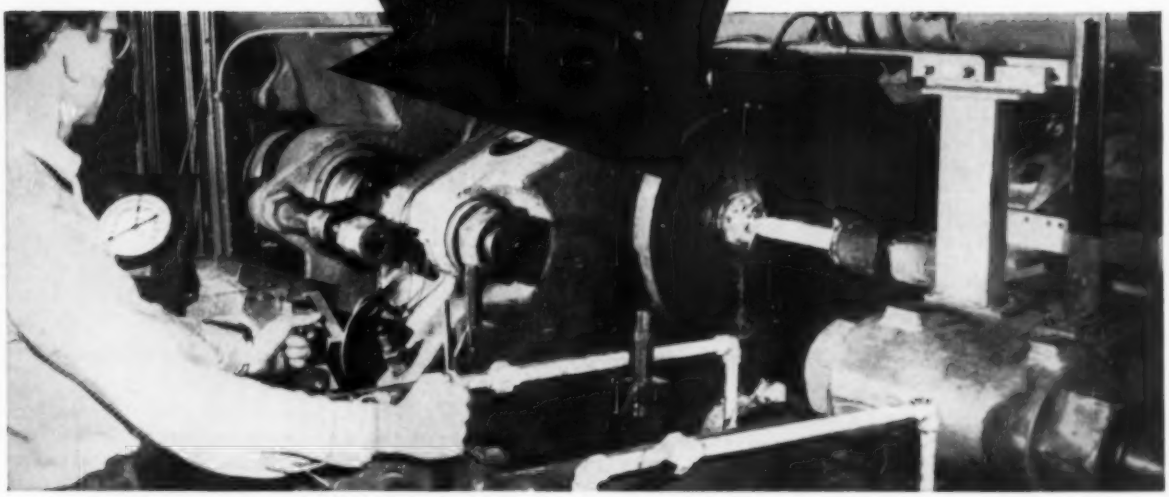

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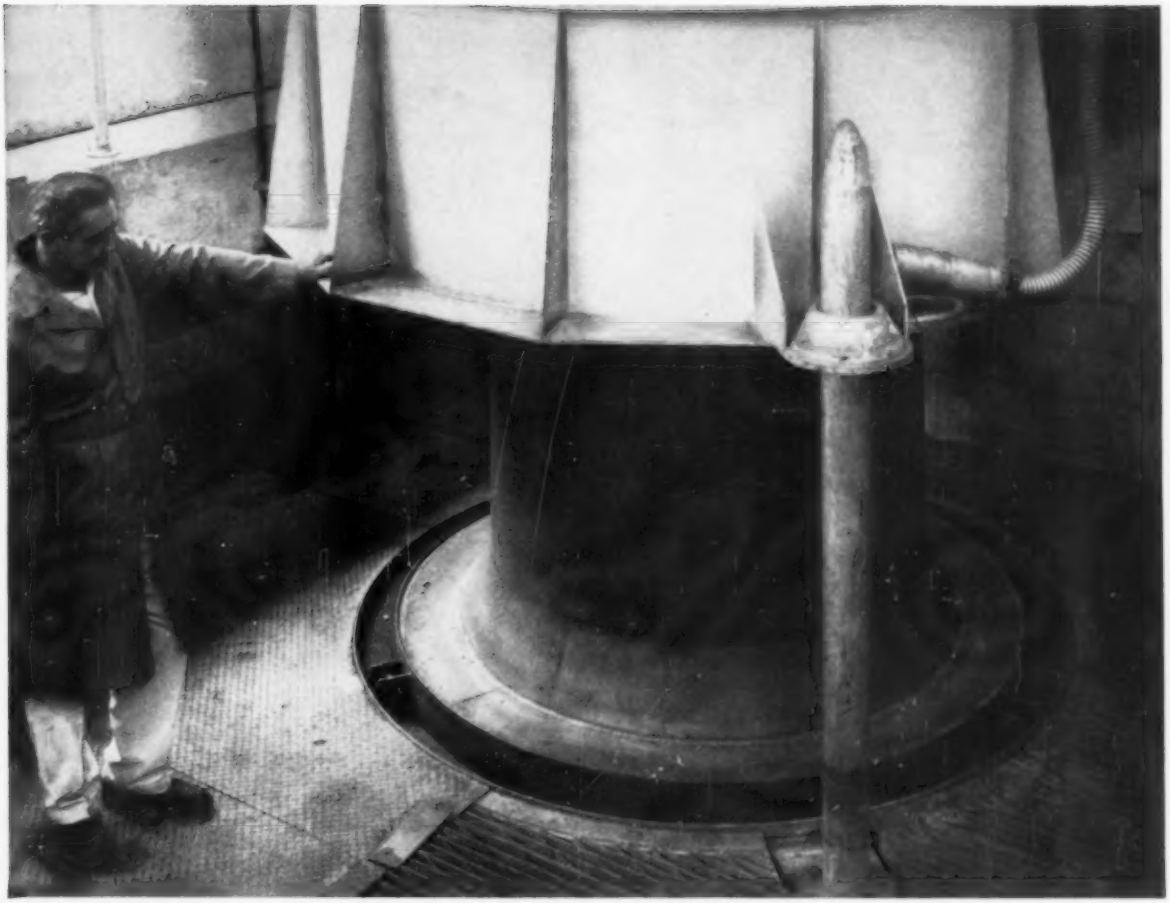

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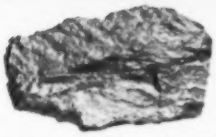

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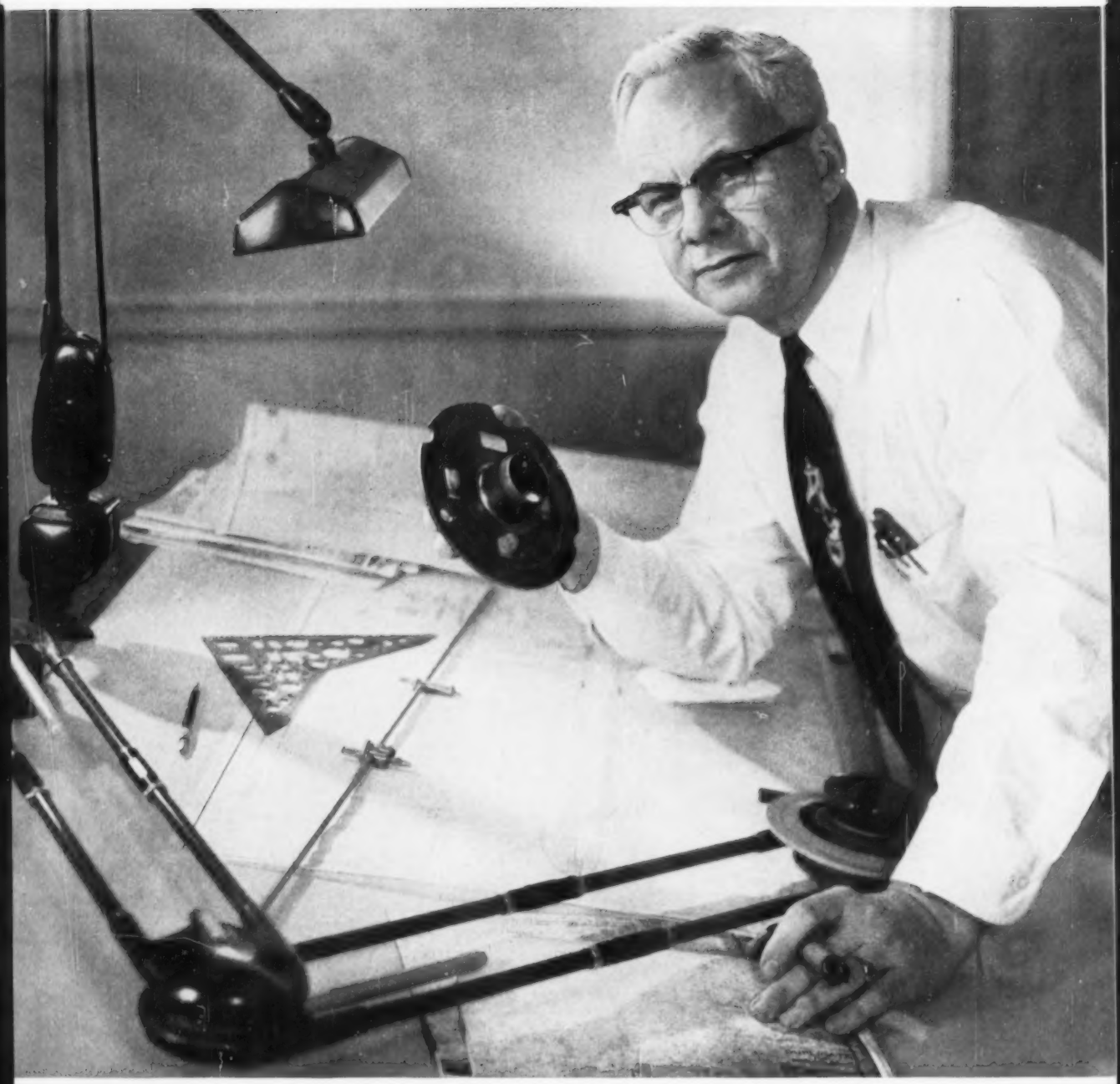

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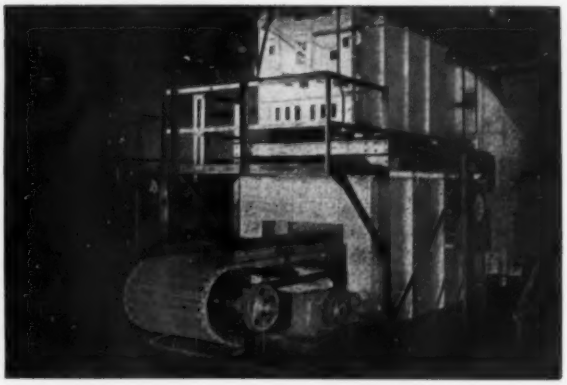

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INDEX TO ADVERTISERS

Abrasive Shot & Grit Co., Inc. 30
Acheson Colloids Co. 149B
Ajax Electric Co. 119
Aldridge Industrial Oils, Inc. 169
Allegheny Ludlum Steel Corp. 96E
Allied Chemical Corp., Nitrogen Division 26
Allied Research Products, Inc. 149
Allis-Chalmers 206
Alloy Engineering & Casting Co. ... 63
Aluminum and Architectural Metals Co. 149A
American Brass Co. 37
American Gas Association 60
American Gas Furnace Co. 195
American Machine and Metals, Inc., Riehle Testing Machine Div. 25E
American Optical Co. 132
American Platinum & Silver Div., Engelhard Industries, Inc. 173
American Society for Metals 201, 212
Ampco Metal, Inc. 39
Arcos Corp. 130, 131, 170
Armour & Co., Ammonia Div. 48
Armstrong-Blum Mfg. Co. 184
Ashworth Brothers, Inc. 190

Baird-Atomic, Inc. 61
Barber-Colman Co. 44, 48C
Bausch & Lomb Optical Co. 96F
Bell & Gossett Co. 207
Bethlehem Steel Co. 37B, 199
Branson Ultrasonic Corp. 161
Budd Co., Nuclear Systems 208
Buehler, Ltd. 32

Cambridge Wire Cloth Co. 203
Cannon-Muskegon Corp. 125
Carborundum Co. 196-197
Carl Mayer Corp. 216
Carlson Co., G. O. 58
The Carpenter Steel Co. 209
Cincinnati Sub-Zero Products Co. 178
Circo Equipment Co. 162
Circo Ultrasonic Corp. 31
Clark Instrument Co. 174
Consolidated Electrodynamics Corp. 41
Copperweld Steel Co. ..... Outside Back Cover
Cowles Chemical Co. 144
Frank L. Crobaugh Co. 169
Curtiss-Wright Corp. 142

Detrex Chemical Industries, Inc. 51
Detroit Flame Hardening Co. 156
Drever Co. 59
Du-Lite Chemical Corp. 163

Eastern Stainless Steel Corp. 123
Eastman Kodak Co. 185
Eclipse Fuel Engineering Co. 168
Electric Furnace Co. ..... Inside Back Cover
Electro Alloys Div., American Brake Shoe Co. 2
Engelhard Industries, Inc., American Platinum & Silver Div. 173
National Electric Instrument Div. 216
Engineered Precision Casting Co. 166
Erie Forge & Steel Corp. 25

Fansteel Metallurgical Corp. 171
Ferro Corp. 163
Ferrotherm Corp. 5
Finkl & Sons Co., A. 194
Foote Mineral Co. 135

Gas Atmospheres, Inc. 37A
General Alloys Co. 215
General Electric Co. 10-11, 186-187
General Electric X-Ray Co. 56
General Extrusions, Inc. 169
General Vacuum Corp. 168
Globe Industries, Inc., Supermet Div. 164
Globe Steel Abrasive Co. 29
Grafo Colloids Corp. 44
Graphite Products Corp. 216
Great Lakes Carbon Corp. 191
Great Lakes Steel Corp. 12-13
Gries Industries, Inc. 161
Grieve Hendry Co., Inc. 168

Handy & Harman 54
Haller, Incorporated 164
Harris Refrigeration Co. 47
Harrop Ceramic Service Co. 216
Hayes, Inc., C. I. 37C
Hevi-Duty Electric Co. 140-141
Holcroft & Co. 48B
Hooker Chemical Corp. 192-193
Hoover Co. 167
Houghton & Co., E. F. 6
Hull & Co., Inc., R. O. 158

International Nickel Co. 96A, 211
Ipsen Industries, Inc. 25C

Jarl Extrusions, Inc. 163
Jones & Laughlin Steel Corp. 16, 200

Kanthal Corp. 121
Kemp Manufacturing Co. 139
Kennametal, Inc. 45
Kent Cliff Laboratories Div., Torsion Balance Co. 167
Kinney Mfg. Div., The New York Air Brake Co. 124
Kocour Co. 162

Lake Chemical Co. 161
LaSalle Steel Co. 57
Latrobe Steel Co. 25D
Little Falls Alloys, Inc. 170
The Lincoln Electric Co. 25G
Lindberg Engineering Co. 151, 152-153
Lucifer Furnaces, Inc. 168

Magnaflux Corp. 28
Magnetic Analysis Corp. 167
Malayan Tin Bureau 180
Malleable Castings Council 146-147
Mallory-Sharon Metals Corp. ..... Inside Front Cover
Markal Co. 170
Martindale Electric Co. 164
Jas. H. Matthews & Co. 165
Maurath, Inc. 168
McDanel Refractory Porcelain Co. 154
Mechanical Devices, Inc. 170
Metal Treating Equipment Exchange, Inc. 169
Metal & Thermit Corp. 62
Mine Safety Appliances Co. 46
Minneapolis-Honeywell Reg., Co. 198, 204-205
Molybdenum Corp. of America 137
Mueller Brass Co. 25A-25B

National Carbon Co., Div. of Union Carbide Corp. 17-23, 181, 210
National Electric Instrument Div., Engelhard Industries 216
National U. S. Radiator Corp., Plastic Metals Division 180
Newage Industries, Inc. 167, 168, 169
The New York Air Brake Co., Kinney Mfg. Div. 124
Nitrogen Division, Allied Chemical Corp. 26
Northwest Chemical Co. 179
Norton Co. 127, 159
Nuclear Systems, Budd Co. 208

Oakite Products, Inc. 150
Ohio Crankshaft Co. 145
Ohio Precision Castings, Inc. 165
Ohio Steel Foundry 129
Olin Mathieson Chemical Corp., Aluminum Div. 157
Opto-Metric Tools, Inc. 166

Pangborn Corp. 160
Park Chemical Co. 133
Pennrold Div. of Brush Beryllium Co. 7
Pereny Equipment Co. 30
Pittsburgh Plate Glass Co. 202
Pressed Steel Co. 31
Pyrometer Instrument Co. 188

Riehle Testing Machine Div., American Machine and Metals, Inc. 25E
Reinhold Publishing Corp. 44
Republic Steel Corp. 182-183
Revco, Inc. 167
Riverside Metal Div. H. K. Porter Company, Inc. 217
Roll Formed Products Co. 163
Rolock, Inc. 136
Rust-Lick, Incorporated 163
Ryerson & Son, Inc., Jos. T. 64

Selas Corporation of America 14-15
Sharon Steel Corp. 214
Shaw Instrument Corp. 166
Shore Instrument & Mfg. Co., Inc. 165
Sieburg Industries, Inc. 166
Smith-Armstrong Forge, Inc. 164
Sorgel Electric Co. 165
Spencer Turbine Co. 175
Sperry Products, Inc. 38, 166
Stanat Mfg. Co., Inc. 148
Stanwood Corp. 169
Star Stainless Screw Co. 164
Steel City Testing Machines, Inc. 25H
F. J. Stokes Corp. 176-177
Sunbeam Corp. 172
Superior Tube Co. 50
Surface Combustion Corp. 8-9
Swift & Co. 189

Technic, Inc. 162
Tempil Corp. 202
Timken Roller Bearing Co. 40
Torsion Balance Co., Kent Cliff Laboratories Div. 44, 167

Union Carbide Corp. National Carbon Co. 17-23, 181, 210
Union Carbide Metals Co. 143
Unitcast Corp. 43
United Carbon Products Co. 164
United States Steel Corp. 33-36
USS Alloy Steel 33
USS Forgings 34-35
USS Lumnite Div. 36
Unit Process Assemblies, Inc. 166
Unitron Instrument Div. of United Scientific Co. 49

Vanadium-Alloys Steel Co. 55
Vanadium Corporation of America 213

Waltz Furnace Co. 126
Waterbury Farrel Foundry & Machine Co. 155
Waukee Engineering Co. 27
Weirton Steel Co. 42
Weston Electrical Instrument Corp. Daystrom-Weston Sales Division 53
Wheelco Instruments Div., Barber-Colman Co. 48C
White Metal Rolling & Stamping Corp. 165
Lee Wilson Engineering Co. 4
Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc. 134, 167
Wiretex Mfg. Co. 163

Yoder Co. 52

Zak Machine Works 174

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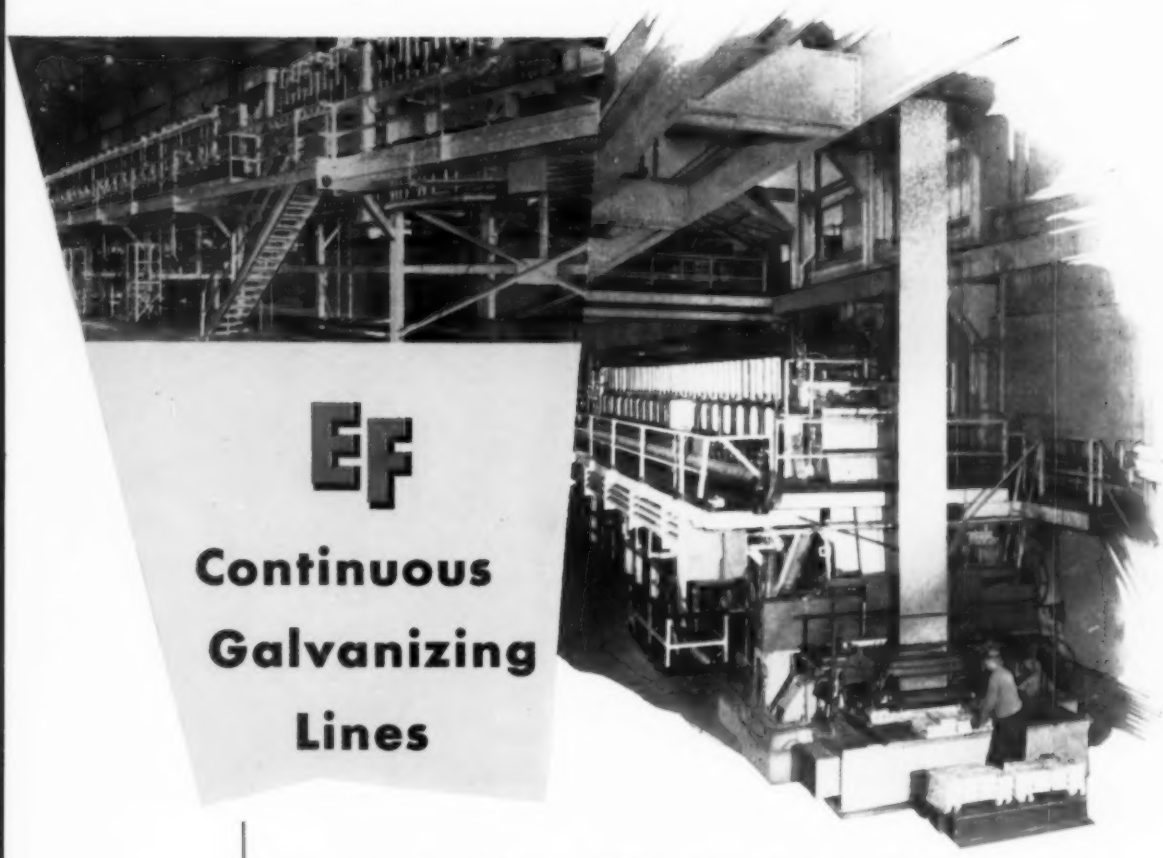

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The unvarying uniformity of product physicals — the bright even spangle — and the tight bond of the coating, preventing chipping or flaking — assure high market acceptance, and make subsequent forming and fabricating operations more efficient and less costly.

For utmost efficiency and economy on galvanizing operations, and all other continuous, or batch, heat treating of ferrous, non-ferrous or alloy materials, you'll find it pays to consult The Electric Furnace Company heat processing engineers.

* Tonnage output will vary depending upon width and gauge of strip being processed.

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Gas-fired, Oil-fired and Electric Furnaces for Heat Treating any Product, Using any Process, any Hourly Output.

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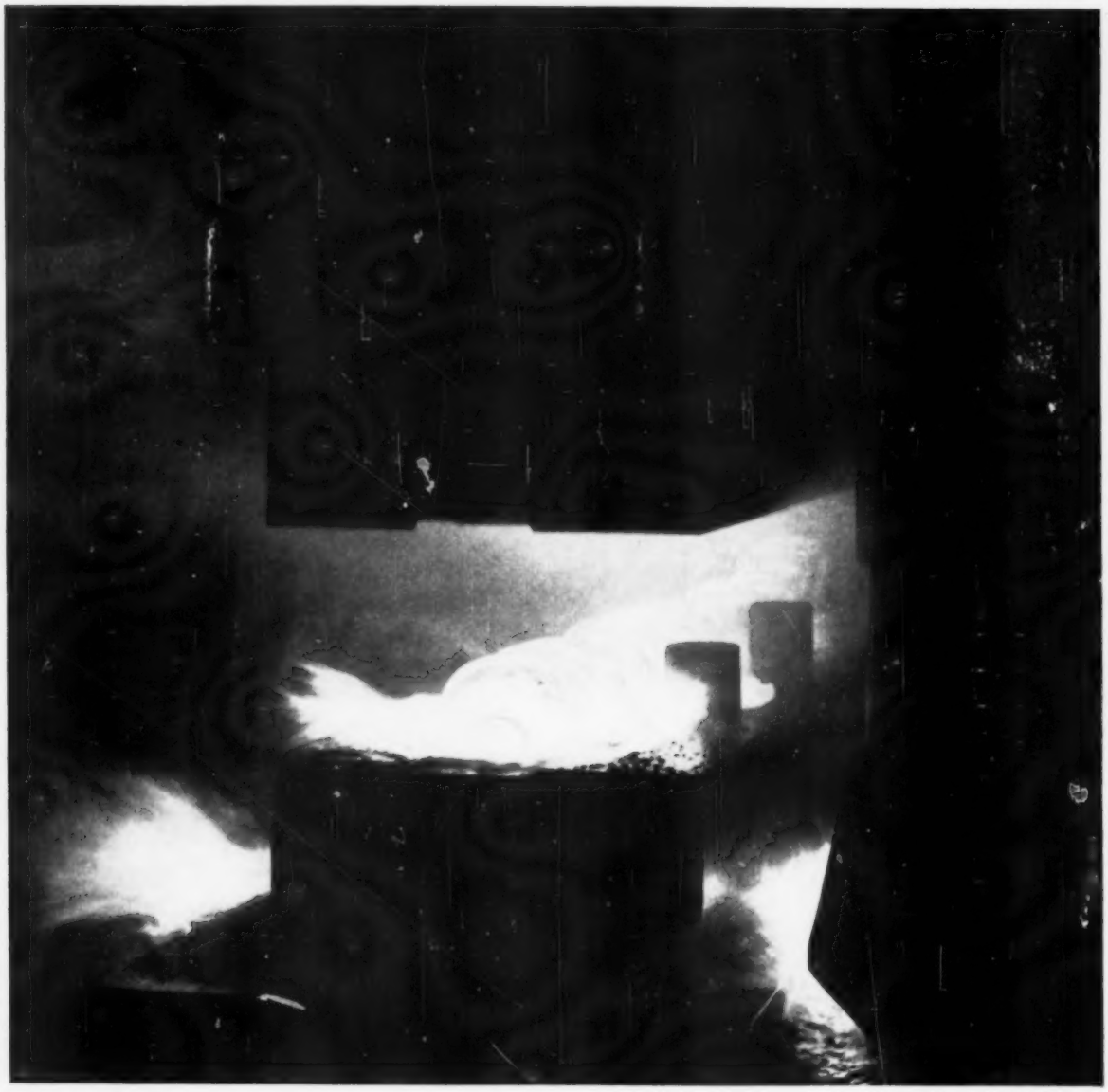

Photo courtesy of The Park Drop Forge Co.

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